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Barangay Residents' Information Management System with Facial Recognition

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ABSTRACT: Many barangays in the Philippines continue to rely on paper-based systems for managing resident records, resulting in inefficiencies, data inaccuracies, and delays in service delivery. This study developed the Barangay Residents' Information Management System with Facial Recognition, a computerized solution designed to digitalize resident data management and enhance identity verification. The system integrates a centralized database for resident profiles, blotter and case records, automated certificate generation, and real-time data visualization dashboards. A facial recognition module enables secure and efficient resident identification, reducing manual processing time and minimizing errors. Developed using the Agile methodology under the Software Development Life Cycle (SDLC), the system was implemented as a Windows-based application using C#, .NET Framework, MySQL, and computer vision libraries. Usability testing results indicate significant improvements in data retrieval speed, record accuracy, and administrative efficiency. The findings demonstrate the effectiveness of digital solutions in modernizing barangay operations and enhancing local governance.

KEYWORDS*:* Information System, Facial Recognition, Digitalization, Information Management, Local Governance, Data Securit

I. INTRODUCTION

Local governance at the barangay level in many rural areas of the Philippines continues to rely on paper-based record management systems. Resident information is commonly stored in logbooks and physical folders, resulting in inefficient data retrieval, vulnerability to record loss or damage, and susceptibility to human error [1]–[3]. These limitations negatively affect data accuracy, administrative efficiency, and service delivery.Although digital transformation offers significant improvements in information management, many rural local government units (LGUs) face infrastructure limitations, financial constraints, and insufficient technical capacity that hinder the adoption of modern systems [1], [3]. The resulting digital divide perpetuates operational inefficiencies such as slow document processing, record mismanagement, and delays in issuing official certifications.Manual processes also impact decision-making and governance. Generating demographic reports requires manual aggregation of data, while identity verification depends solely on physical identification documents. These limitations highlight the need for a secure and efficient digital solution tailored to barangay operations.

This study proposes the development of a Barangay Information Management System integrated with Facial Recognition technology. The system digitalizes resident profiling, blotter management, and automated document generation through a centralized database platform. It also incorporates data visualization tools for real-time demographic reporting and planning support. A facial recognition module is implemented to enable accurate and rapid resident identification through biometric matching, reducing reliance on physical identification documents. The proposed system aims to improve administrative efficiency, data integrity, and service delivery while providing a scalable model for technology-driven modernization of barangay governance.

Conceptual Framework : The conceptual framework of this study is based on the Input–Process–Output (IPO) model integrated with a continuous feedback mechanism to ensure system improvement and sustainability. It illustrates how raw data collected from barangay operations are transformed through system processes into meaningful outputs that support governance and service delivery.

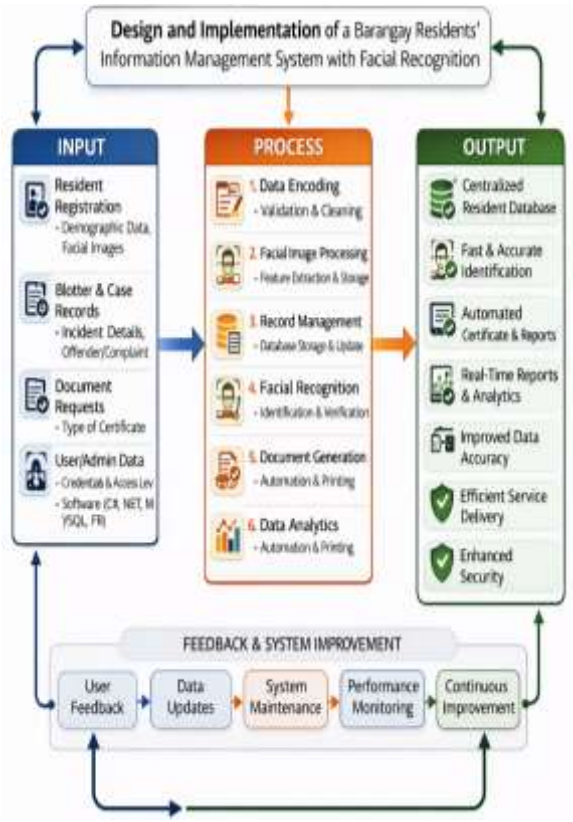

Figure 1 presents the conceptual framework of the proposed system.

The input component consists of resident demographic data, facial image data, blotter and case records, document requests, user credentials, and system resources such as hardware and software infrastructure. These inputs represent the foundational data and operational requirements necessary for system functionality. The process component includes data encoding and validation, facial image processing, record management, facial recognition-based verification, automated document generation, and data analytics. During this stage, the system applies biometric matching algorithms, database management operations, and automated workflows to transform raw inputs into structured and secured information. The output component produces a centralized resident database, fast and accurate identity verification, automated certificates and reports, real-time analytics dashboards, improved data accuracy, enhanced security, and efficient service delivery. These outputs reflect the operational benefits and improvements achieved through system implementation. A feedback mechanism connects the outputs back to the input and process stages through user feedback, performance monitoring, system maintenance, and data updates. This loop ensures continuous evaluation, refinement, and optimization of the system to maintain efficiency, accuracy, and adaptability over time. Overall, the framework demonstrates how integrated data management and facial recognition technology transform manual barangay operations into a secure, automated, and continuously improving information system.

II. METHODOLOGY

Research Design and Development Model : This study adopted an Agile-driven Software Development Life Cycle (SDLC) using the Prototyping Model to support iterative development and continuous user feedback. The approach enabled progressive refinement of system features based on the operational requirements of the barangay and ensured alignment with real-world workflows.

Planning and Requirements Elicitation : System requirements were gathered through consultations, interviews, and surveys with barangay officials. Existing manual procedures, user roles, data collection processes, reporting needs, and document workflows were analyzed. Risk assessment was conducted to address data privacy compliance with the Data Privacy Act of 2012, facial recognition accuracy, and potential system vulnerabilities.

System Analysis : The collected requirements were translated into functional specifications by analyzing current data flows and identifying opportunities for automation and optimization. The analysis defined the major system modules: resident profiling, facial recognition, blotter and case management, document generation, and demographic reporting.

System Design: The system architecture, database structure, and user interface were designed to provide an intuitive and efficient workflow requiring minimal training. Unified Modeling Language (UML) diagrams were used to model system behavior and structure, including use case, class, sequence, and entity–relationship diagrams. A relational database schema was developed to ensure data integrity, consistency, and secure storage of resident records, facial embeddings, transactions, and activity logs. Standardized input forms and automated document templates were designed to improve data accuracy and processing time.

Development Environment and Technologies : The application was developed as a Windows Forms desktop system using C# under the .NET Framework, with MySQL as the backend database.

Facial recognition was implemented using Emgu.CV and FaceRecognitionDotNet for face detection, encoding, and matching.

Automated document and report generation utilized the DocX and EPPlus libraries.

The system requires a Windows-based computer and a webcam for facial capture.

System Implementation : Development followed an iterative module-based approach under Agile methodology. Core functionalities included role-based authentication, CRUD operations, biometric registration and identification, report generation, and activity logging. The system was deployed through an installer package containing required libraries, database schema, and configuration guidelines.

Testing and Validation : A structured test plan covering unit, integration, and usability testing was implemented. Test data consisting of sample resident profiles and facial images simulated real-world scenarios.Barangay officials and IT experts served as respondents for system evaluation based on the ISO 25010 software quality model. The system was evaluated in terms of Functional Stability, Usability, Performance Efficiency, Reliability, Security, Maintainability, Portability and Compatibility.

Maintenance and Future Enhancement : Post-deployment maintenance includes database backup, user account management, system monitoring, and periodic updates. Future enhancements may involve improving the facial recognition model, adding document templates, and expanding system functionality based on user feedback.

III. RESULTS AND DISCUSSIONS

To validate the quality and effectiveness of the developed system, an evaluation was conducted based on the ISO 25010 software quality model. The evaluation involved two groups of respondents: Barangay Officials, representing the end-users, and IT Experts, providing a technical assessment. The results for each characteristic are presented and discussed below.

Table 1 shows the evaluation results for Functional Suitability. The system achieved an outstanding grand mean of 4.77, interpreted as "Excellent" based on the combined ratings of Barangay Officials and IT Experts.

Table 1. Result of the Functionality of the System

Functional Suitability	Brgy. Officials	IT Experts	Composite Mean	**Description**
Correctness	5.00	4.50	4.75	Excellent
Completeness	5.00	4.50	4.75	Excellent
Appropriateness	5.00	4.60	4.80	Excellent
Grand Mean			**4.77**	**Excellent**

Functional Suitability (ISO/IEC 25010). In accordance with the quality model defined in ISO/IEC 25010, Functional Suitability refers to the degree to which a system provides functions that meet stated and implied

needs when used under specified conditions. The evaluation results indicate that the proposed system achieved uniformly high ratings across all Functional Suitability sub-characteristics. Specifically, Functional Completeness and Functional Correctness both obtained a composite mean of 4.75, interpreted as "Excellent," demonstrating that the system fully implements the required functions and produces accurate and precise results for resident information management processes. Moreover, Functional Appropriateness achieved a composite mean of 4.80 ("Excellent"), indicating that the implemented features, including the facial recognition capability, effectively support users in accomplishing specified tasks efficiently and appropriately within the barangay context. These findings confirm that the system satisfies the Functional Suitability requirements as defined by ISO/IEC 25010 and effectively fulfills its intended purpose as an information management solution.

The data presented in Table 2 details the results for Usability. The system earned a grand mean of 4.77, corresponding to an "Excellent" rating from both user groups.

Table 2. Result of the Usability of the System

Usability	Brgy. Officials	IT Experts	Composite Mean	**Description**
Learnability	5.00	4.30	4.65	Excellent
Operability	5.00	4.60	4.80	Excellent
User Error Protection	5.00	4.70	4.85	Excellent
Grand Mean			**4.77**	**Excellent**

Usability (ISO/IEC 25010). In accordance with the quality model defined in ISO/IEC 25010, Usability refers to the degree to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. The evaluation results show that the proposed system attained consistently high ratings across all assessed Usability sub-characteristics. Specifically, Learnability, Operability, and User Error Protection each obtained a composite mean of 4.65, 4.80 and 4.85, interpreted as "Excellent." These findings indicate that users were able to quickly understand and become proficient in using the system, navigate its functions with ease, and effectively prevent and recover from input errors. The results therefore demonstrate that the system successfully achieves its objective of providing a user-friendly interface suitable for barangay personnel with varying levels of technical expertise.

Table 3 displays the results for Performance Efficiency, where the system received a grand mean of 4.68, interpreted as "Excellent".

Table 3. Result of the Performance Efficiency of the System

Performance Efficiency	Brgy. Officials	IT Experts	Composite Mean	**Description**
Time Behaviour	5.00	4.40	4.70	Excellent
Resource Utilization	5.00	4.30	4.65	Excellent
Grand Mean			**4.68**	**Excellent**

Performance Efficiency (ISO/IEC 25010). As defined in ISO/IEC 25010, Performance Efficiency refers to the degree to which a system delivers appropriate performance relative to the amount of resources used under stated conditions. The assessment of the proposed system focused on the sub-characteristics of Time Behavior and Resource Utilization. The results indicate that Time Behavior achieved a composite mean of 4.70, interpreted as "Excellent," demonstrating that essential operations—including application startup, resident search, and facial recognition identification—are executed within acceptable response times and without significant delays. Resource Utilization obtained a composite mean of 4.65 ("Excellent"), indicating that the system efficiently manages processing and memory resources without imposing excessive computational load. These findings confirm that the system satisfies the Performance Efficiency requirements specified in ISO/IEC 25010.

The results for Reliability are shown in Table 4. The system obtained a grand mean of 4.775, corresponding to an "Excellent" rating.

Table 4. Result of the Reliability of the System

Reliability	Brgy. Officials	IT Experts	Composite Mean	**Description**
Maturity	5.00	4.60	4.80	Excellent
Fault Tolerance & Recoverability	5.00	4.50	4.75	Excellent
Grand Mean			**4.775**	**Excellent**

Reliability (ISO/IEC 25010). As defined in ISO/IEC 25010, Reliability refers to the degree to which a system performs specified functions under specified conditions for a specified period of time. The evaluation of the proposed system focused on the sub-characteristics of Maturity and Fault Tolerance (including aspects of Recoverability). The results indicate that Maturity achieved a composite mean of 4.80, interpreted as "Excellent," demonstrating that the system operates consistently under normal conditions without crashes or unexpected failures. Similarly, Fault Tolerance and Recoverability obtained a composite mean of 4.75 ("Excellent"), indicating a high level of user confidence in the system's ability to maintain data integrity and restore information effectively through its implemented backup mechanism. These findings confirm that the system meets the Reliability requirements specified in ISO/IEC 25010.

As detailed in Table 5, the system's Security features were evaluated with a grand mean of 4.825, earning an "Excellent" rating.

Table 5. Result of the Security of the System

Security	Brgy. Officials	IT Experts	Composite Mean	**Description**
Access Control	5.00	4.7	4.85	Excellent
Confidentiality	5.00	4.6	4.80	Excellent
Grand Mean			**4.825**	**Excellent**

Security (ISO/IEC 25010). As defined in ISO/IEC 25010, Security refers to the degree to which a system protects information and data so that persons or other systems have the degree of data access appropriate to their types and levels of authorization. The evaluation of the proposed system focused on the sub-characteristics of Confidentiality and Access Control. Sub-characteristics obtained a composite mean of 4.85 and 4.80, interpreted as "Excellent." These results indicate that the implemented authentication mechanisms—specifically the username and password login system, together with a secure password reset feature—effectively safeguard sensitive resident information against unauthorized access. The findings therefore confirm that the system satisfies the Security requirements defined in ISO/IEC 25010.

Table 6 presents the results for Maintainability, which received a grand mean of 4.80, interpreted as "Excellent".

Table 6. Result of the Maintainability of the System

Maintainability	Brgy. Officials	IT Experts	Composite Mean	**Description**
Analyzability	5.00	4.6	4.80	Excellent
Modifiability	5.00	4.6	4.80	Excellent
Grand Mean			**4.80**	**Excellent**

Maintainability (ISO/IEC 25010). In accordance with ISO/IEC 25010, Maintainability refers to the degree of effectiveness and efficiency with which a system can be modified by the intended maintainers. The evaluation results indicate that both Barangay Officials and IT experts expressed exceptional confidence in the system's long-term maintainability.

The sub-characteristic Analyzability achieved a composite mean of 4.80, interpreted as "Excellent," demonstrating that the system's architectural structure and code organization are clear, well-structured, and easy to diagnose in the event of defects or required enhancements. Likewise, Modifiability obtained a composite mean of 4.80 ("Excellent"), indicating strong confidence that future modifications, feature enhancements, or functional updates can be implemented efficiently and without introducing unintended defects. These findings confirm that the system satisfies the Maintainability requirements specified in ISO/IEC 25010.
The results for Portability are shown in Table 7, with the system achieving a grand mean of 4.75, or an "Excellent" rating.

Table 7. Result of the Portability of the System

Portability	Brgy. Officials	IT Experts	Composite Mean	**Description**
Installability	5.00	4.40	4.70	Excellent
Adaptability	5.00	4.60	4.80	Excellent
Grand Mean			**4.75**	**Excellent**

Portability (ISO/IEC 25010). As defined in ISO/IEC 25010, Portability refers to the degree of effectiveness and efficiency with which a system can be transferred from one hardware, software, or operational environment to another. The evaluation of the proposed system focused on the sub-characteristics of Installability and Adaptability. The results indicate that Installability achieved a composite mean of 4.70, interpreted as "Excellent," confirming that the system can be deployed efficiently on a new computing environment. Similarly, Adaptability obtained a composite mean of 4.80 ("Excellent"), demonstrating that the system can be readily configured or transferred across environments. In this context, adaptability includes the capability to migrate data through the implemented backup and restore mechanisms. These findings indicate that the system is not dependent on a single machine and can be effectively migrated or recovered in the event of hardware failure, thereby satisfying the Portability requirements specified in ISO/IEC 25010.

As shown in Table 8, the system's Compatibility was assessed with a grand mean of 4.80, corresponding to an "Excellent" rating.

Table 8. Result of the Compatibility of the System

Compatibility	Brgy. Officials	IT Experts	Composite Mean	**Description**
Co-existence	5.00	4.70	4.85	Excellent
Interoperability	5.00	4.50	4.75	Excellent
Grand Mean			**4.80**	**Excellent**

Compatibility (ISO/IEC 25010). In accordance with ISO/IEC 25010, Compatibility refers to the degree to which a system can operate effectively while sharing an environment with other systems and exchange information when required. The evaluation results yielded a grand mean of 4.80 ("Excellent"), indicating a high level of compatibility. Specifically, Co-existence achieved a composite mean of 4.85, while Interoperability obtained a composite mean of 4.75, both interpreted as "Excellent." These findings demonstrate that the system can function efficiently alongside other applications without resource conflicts and can effectively exchange and utilize information with other systems, thereby satisfying the Compatibility requirements defined in ISO/IEC 25010.

Table 9 summarizes the overall system performance across all eight characteristics of the ISO 25010 standard. The system yielded an outstanding grand mean of 4.77, which is interpreted as "Excellent".

Table 9. Overall Result of the System Performance using ISO Standard 25010

Functionality	Mean	**Description**
Functional Stability	4.77	Excellent
Usability	4.77	Excellent
Performance Efficiency	4.68	Excellent
Reliability	4.775	Excellent
Security	4.825	Excellent
Maintainability	4.80	Excellent
Portability	4.75	Excellent
Compatibility	4.80	Excellent
Grand Mean	**4.77**	**Excellent**

Overall System Quality Evaluation (ISO/IEC 25010). Based on the quality characteristics defined in ISO/IEC 25010, the proposed system demonstrated consistently high performance across all evaluated dimensions. The results indicate that Functional Suitability obtained a mean of 4.77, Usability 4.77, Performance Efficiency 4.68, Reliability 4.775, Security 4.825, Maintainability 4.80, Portability 4.75, and Compatibility 4.80, all interpreted as "Excellent." The overall grand mean of 4.77 ("Excellent") reflects a very high level of compliance with the ISO/IEC 25010 quality model. These findings collectively confirm that the system meets established international software quality standards and is functionally appropriate, secure, efficient, reliable, maintainable, portable, and compatible within its intended operational environment.

IV. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Conclusion: Based on the findings, the researchers conclude that the proposed system successfully achieves its intended objectives. First, the implementation of the digital platform addresses common issues inherent in manual record-keeping systems, including data redundancy, misplaced records, and delayed processing times. Second, the facial recognition module proved to be an effective and practical mechanism for identity verification within the barangay setting, offering a faster alternative to manual name-based searches. Third, the system enhances governance by providing real-time graphical summaries and structured demographic categorization, thereby enabling data-driven decision-making and improved public service delivery. Finally, the high evaluation ratings in Maintainability and Compatibility indicate that the system possesses sufficient robustness and scalability to support long-term sustainability and future expansion.

Recommendations: To ensure continuous improvement and long-term sustainability, several enhancements are recommended. Given the sensitivity of personal and biometric information, strengthening security mechanisms is strongly advised. This includes implementing Two-Factor Authentication (2FA) for administrative accounts, enabling Secure Sockets Layer (SSL) encryption, and automating regular database backups to ensure compliance with the Data Privacy Act of 2012. It is further recommended to develop a web-based and mobile-accessible version of the system to increase accessibility and scalability. This would involve migrating the application to a secure server infrastructure using modern web development frameworks. The integration of an SMS gateway API is also suggested to enable automated notifications and improve communication with residents. Future enhancements to the facial recognition module may focus on improving performance under low-light conditions and supporting multiple facial data entries per resident. Additionally, the development of an online constituent portal would allow residents to submit document requests and update non-sensitive personal information remotely. Continuous capacity-building initiatives should be conducted to train barangay personnel not only in

system usage but also in responsible data handling practices, particularly in relation to privacy and ethical management of biometric information. Finally, migrating the system from a purely local deployment to a secure cloud hosting environment is recommended to ensure disaster resilience, data redundancy, and uninterrupted access in cases of hardware damage or natural calamities.

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