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Evaluating Health Services and Operations among Barangay Health Offices: Basis for Document Digitalization with Text Classification Algorithm and Machine Learning

Jaspergen D. Dahilan and Riah E. Encarnacion
ORCID:0009-0007-7013-9621, 0000-0003-3760-7458
Department of Graduate Studies
Surigao Del Norte State University, Surigao City, Philippines
jdahilan@ssct.edu.ph, rencarnacion@ssct.edu.ph

Abstract: *Barangay Health Offices (BHOs) plays an important role in delivering primary healthcare services to local communities. However, many of its operations still rely on outdated manual systems for document reporting and analysis. The process of digitalizing document reporting and analysis presents an opportunity to streamline processes, enhance efficiency, accuracy, and accessibility of health-related information, and enable better data-driven decision-making at the barangay level. It is for this reason that the researchers intend to address the problem within the Barangay Health Offices (BHOs) of Surigao City. By analyzing the needs of the 20 female BHO workers and utilizing a mixed-methods approach, various aspects of health service provision and operational transactions were evaluated. The findings revealed positive perceptions among respondents, particularly in Health Services Provision (WM = 4.2), resource availability (WM = 3.85), data security (WM = 3.05), and infrastructure (WM = 2.53). However, infrastructure challenges such as internet speed and computer availability were highlighted as areas needing improvement. Data security measures were also identified as requiring enhancement through encryption and regular audits. The survey results will be essential in creating the proposed digitalization framework aimed at enhancing the efficiency, accuracy, and accessibility of health-related information using text classification algorithm and machine learning. This research exploration hasalso contributed valuable insights for policymakers and health administrators seeking to optimize health services provision at the grassroots level. The proposed digitalization framework will be a pathway towards improved healthcare delivery and operational effectiveness*

Keywords: Barangay Health Offices, health services, operational transactions, digitalization framework, document reporting, health information management, data security, infrastructure improvement, mixed methods.

I. INTRODUCTION

In today's rapidly evolving technological landscape, Barangay Health Offices (BHOs) faced a significant challenge in managing and accessing crucial health-related documents. These offices are crucial in delivering primary healthcare services to local communities, yet many still rely on outdated manual systems for document reporting and analysis. This reliance poses substantial challenges including inefficiencies, delays, inaccuracies, and limited data-driven decision-making capabilities. These shortcomings are particularly evident in BHOs in Surigao City, where the efficient management of health-related documents is vital for improving healthcare delivery and outcomes at the community level. In recognizing this challenge, there arises a compelling need for a modernized solution—a digitalized document reporting and analysis system [1] tailored specifically to the unique requirements of BHOs. The proposed system, with the integration of text classification [13][15] and machine learning [10][11], will revolutionize the management of

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health-related documents by enhancing efficiency, accuracy, and accessibility of information, and enabling better data-driven decision-making at the barangay level.

By addressing this need, the proposed digitalization framework will not only streamline the document reporting and analysis processes but also support BHOs in their pursuit of continuous improvement and enhanced healthcare provision. Moreover, it reinforces the commitment to transparency, accountability, and the delivery of high-quality healthcare services, thereby enhancing the standing of BHOs within the community and beyond.

II. OBJECTIVES OF THE STUDY

The objectives of the study can be formulated as follows:

- To assess the performance level of the existing system of health services provision and operation transactions among Barangay Health Offices (BHOs) in Surigao City.
- To propose a comprehensive digitalization framework tailored for specifically for document reporting and analysis using text classification and machine learning.
- To formulate recommendation aimed at further enhancing and scaling up the provision of health services and operational transactions within BHOs.

III. RELATED LITERATURE

3.1 Digitalization and Information Systems in the Healthcare Sector

The efforts to strengthen digital health information systems are essential for optimizing data utilization and improving healthcare delivery. This is evident in the works of Oderkirk et al. [3] that highlighted collaborative approaches to maximize data use for direct care and secondary purposes, emphasizing the need to align stakeholders and enhance data utilization strategies. In addition, the study by Gavrilov et al. [2] underscores the significance of digitalization in enhancing administrative processes and fulfilling healthcare obligations. They emphasize its positive effects on insured individuals, healthcare providers, and companies, highlighting the essential role of digital transformation in improving healthcare quality and financing.

The study by Campanella et al. [4] reveals the benefits of electronic health records (EHRs) in improving patient outcomes, reducing medical errors, and streamlining workflows. Despite these benefits, challenges such as interoperability and data security remain significant considerations in EHR adoption and implementation.

Stampe et al. [6] investigate the impact of mobile health (mHealth) apps on chronic disease management, demonstrating improved self-management behaviors and health outcomes. However, privacy concerns and usability challenges exist, necessitating careful consideration of app design and implementation strategies.

Menachemi et al. [8] evaluate the impact of health information exchange (HIE) systems, demonstrating improvements in care coordination, test reduction, and patient safety. However, interoperability challenges and legal considerations pose barriers to widespread HIE adoption.

Du et al. [5] also explore the adoption of telemedicine in rural areas, emphasizing its role in improving access to healthcare services and addressing disparities. They highlight the influence of infrastructure, reimbursement policies, and patient acceptance on telemedicine adoption, underscoring the importance of policy support and digital literacy initiatives.

3.2 Integration of Artificial Intelligence and Machine Learning (AI) in Healthcare

Bajwa et al. [7] analyze the role of artificial intelligence (AI) in healthcare, highlighting its potential in disease detection, risk assessment, and clinical decision-making. Despite the promising benefits, ethical considerations and data bias require attention to ensure responsible AI adoption in healthcare settings. Likewise, Butt et al. [11] discuss artificial intelligence and machine learning in global healthcare. They underscore the value that these technologies bring to the industry, from improving diagnostic accuracy to predicting patient survival rates.

The systematic literature review by Kitsios et al. [9] discusses recent advances in AI in healthcare. The review covers both the benefits and the issues that AI capabilities provide for individuals, medical professionals, corporations, and the health industry.

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Panesar et al. [10] discuss the role of 5G and IoT in intelligent healthcare. They highlight the use of machine learning and AI in healthcare, emphasizing the potential of these technologies to revolutionize healthcare delivery and patient care.

2.3 Text Classification Techniques

Yao et al. [12] present a method combining rule-based features with knowledge-guided convolutional neural networks for clinical text classification. Their approach, which leverages trigger phrases and Unified Medical Language System (UMLS) entity embeddings, demonstrates superior performance in disease classification tasks.

Figueira et al. [13] explore multi-label text classifications in healthcare, proposing modifications to the AttentionXML model to provide justifications for each decision. This aids medical coders by highlighting relevant text spans, thereby enhancing the transparency of AI-assisted medical record classification.

Hughes et al. [14] introduce an approach using deep convolutional neural networks to classify clinical text at a sentence level. Their method outperforms traditional natural language processing techniques by about 15%, showcasing the effectiveness of deep learning in semantic clinical classification.

Liu et al. [15] discuss the challenges of high-quality text classification for healthcare information support. The study presents a case study on Chinese disease-related information, emphasizing the importance of precision and recall in classifying texts into suitable healthcare categories.

Chaib et al. [16] analyze the impact of combining handcrafted and doc2vec features in multi-label medical text classification. Their system, MUL-MEDTEC, achieves high classification accuracy on the Ohsumed medical dataset, illustrating the benefits of feature cooperation in medical text categorization.

IV. METHODOLOGY

4.1 Research Approach

This study utilized a mixed-methods approach, combining both quantitative and qualitative methods. This approach enabled a comprehensive investigation of the digitalization of health services in Barangay Health Offices (BHOs), providing a deeper understanding of the topic by triangulating different types of data. The quantitative data provided statistical insights into the performance and feasibility of digitalization, while the qualitative data offered insights into the challenges and opportunities for improvement.

4.2 Research Design

A sequential explanatory research design was employed in the study starting with quantitative data collection followed by qualitative data collection and data analysis. The quantitative research, in a form of an online survey, has collected numerical data which quantify relationships between variables related to the digitalization process in BHOs. This phase provided statistical insights and identified key trends and patterns.

Following the quantitative phase, the qualitative method involved in-depth interviews to explore and understand the experiences and perceptions of stakeholders involved in the digitalization of BHOs. This phase aimed to uncover underlying meanings, patterns, and themes within the data, providing a richer, more nuanced understanding of the quantitative findings. The sequential explanatory design allowed for the exploration of relationships between variables identified in the quantitative phase and provided a more in-depth understanding of the findings.

4.3 Research Instrument

4.3.1 Survey Questionnaire

The survey questionnaires include questions related to the performance level of existing systems, the feasibility and benefits of digitalization, and demographic information of the respondents. The link to the online survey questionnaire was distributed to the selected respondents through Google forms, allowing for efficient data collection and analysis.

4.3.2 Interview

Semi-structured interviews were conducted to gather qualitative data on the challenges, gaps, and opportunities for improvement in health service provision and operational transactions within the BHOs. The interviews were audio-

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recorded and transcribed for analysis. Interview questions focused on gathering detailed insights into the current practices, challenges faced, and suggestions for improvement regarding the digitalization of health services in BHOs.

4.3.3 Validation of Research Instruments

To ensure the validity and reliability of the survey questionnaire and interview guide, a pilot test was conducted with a small group of respondents. The feedback from the pilot test was used to refine the instruments before full-scale data collection.

4.4 Data Collection

The data were collected through survey questionnaires and interviews. The survey questionnaires, designed using Google Forms, collected the quantitative data on the performance level of existing systems and to assess the feasibility and benefits of digitalization. The interviews were conducted face-to-face or through social media platforms to gather qualitative data on challenges, gaps, and opportunities for improvement.

4.5 Research Participants and Sampling Method

The population of interest includes twenty (20) female workers aged 20 years old to 60 years old from BHOs in barangays of Togbongon, Luna, Taft, and San Roque in Surigao City, Surigao del Norte, Philippines. A purposive sampling technique was employed to select the respondents who are directly involved in health service provision and operational transactions within the BHOs. Purposive sampling is chosen to ensure that the selected respondents have the relevant knowledge and experience to provide valuable insights into the research questions.

4.6 Data Analysis

This study employed a mixed methods approach to analyze the data collected from both the quantitative survey questionnaires and qualitative interviews. The quantitative data analysis begun with descriptive statistics to summarize the performance level of existing systems, as well as responses regarding the feasibility and benefits of digitalization. Descriptive statistical methods, such as frequency distribution, weighted mean and standard deviation were computed to show results of the variables and identify trends. Table 1.0 presents the interpretation of the computed weighted mean score for the respondents' level of assessment of the current manual system of health services provision and operational transactions among Barangay Health Offices (BHOs) in Surigao City.

TABLE 1.0: INTERPRETATION OF RANGE OF THE WEIGHTED MEAN

Range of the Weighted Mean	Interpretation
4.51 – 5.00	Strongly Agree (for the questions asked)
3.51 – 4.50	Agree (for the questions asked)
2.51 – 3.50	Moderately Agree (for the questions asked)
1.51 – 2.50	Disagree (for the questions asked)
1.50 and below	Strongly Disagree (for the questions asked)

Meanwhile, the qualitative data from the interviews underwent thematic analysis to identify key patterns and themes related to challenges, gaps and opportunities for improvement in health service provision and operational transactions within the BHOs. This analysis involved coding the interview transcripts, categorizing the code into themes, and interpreting the finding in the context of the research objectives.

The integration of both quantitative and qualitative findings was achieved through data triangulation, where the results from both methods will were compared and contrasted to provide a comprehensive understanding of the digitalization of health services in BHOs. This integrated analysis will help validated the findings and provide a solid basis for recommendations aimed at enhancing health service delivery in BHOs.

V. RESULTS AND DISCUSSION

This chapter discusses the analysis and interpretation of the data gathered from participants' responses in answering the specific questions of the study of proposed document digitalization with text classification algorithm and machine learning.

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5.1 Demographic Profile of the Respondents

TABLE 2.0: PROFILE OF THE RESPONDENTS IN TERMS OF GENDER

Gender	Frequency	Percentage %
Male	0	0
Female	20	100%
Total	**20**	**100%**

Table 2.0 presents the gender-specific profile of the responders. It reveals that all Barangay Health personnel, who include roles such as Nurses, Midwives, and other Health personnel, are exclusively female.

TABLE 3.0: PROFILE OF THE RESPONDENTS IN TERMS OF AGE CLASSIFICATION

Age	Frequency	Percentage %
18 -25	0	0
26 - 35	7	35%
36 - 45	9	45%
46 - Above	4	20%
Total	**20**	**100%**

Table 3.0 illustrates the age distribution of Barangay Health workers. It indicates that the majority of female workers fall within the 36-45 age bracket, accounting for 45% of the total. This is followed by the 26-35 age groups, which makes up 35% of the workforce. The age group of 46 and above represents the remaining 20%. Notably, there are no workers in the 18-25 age brackets.

TABLE 4.0: PROFILE OF THE RESPONDENTS IN TERMS OF BARANGAY LOCATION

Barangay	Frequency	Percentage %
Togbongon	10	50%
San Roque	6	30%
Luna	4	20%
Total	**20**	**100%**

Table 4.0 shows the distribution of respondents across three barangays. Half of the respondents 50% are from Barangay Togbongon, making it the most represented barangay. Barangay San Roque follows with 30% of the respondents, while Barangay Luna has the least representation with 20%. Despite the differences in representation, each barangay contributes valuable insights to the study. The total number of respondents is 20, ensuring a diverse range of experiences and perspectives.

TABLE 5.0: PROFILE OF THE RESPONDENTS IN TERMS OF POSITION

Barangay	Frequency	Percentage %
Nurse	0	0%
Midwife	2	2%
Health Worker	18	90%
Total	**20**	**100%**

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Table 5.0 presents the profile of respondents in terms of their positions. The majority of the respondents 90% are Health Workers, while a small portion 2% are Midwives. Interestingly, there are no Nurses as they we absent due to an ongoing seminar. This distribution provides a perspective on the roles of the respondents within their respective Barangay Health Offices.

TABLE 6.0: PROFILE OF THE RESPONDENTS IN TERMS OF YEARS OF SERVICE

Barangay	Frequency	Percentage %
Less than 1 year	11	55%
2 years	6	30%
3 years	18	90%
4 years	0	0%
5-10 years of more	1	10%
Total	**20**	**100%**

Table 6.0 shows that most respondents 55% have served less than a year in their barangay roles, likely due to recent administrative changes. A significant 30% have served for two years, and a surprising 90% for three years, indicating past stability. No respondents have served for four years, while a small 10% have served for five to ten years or more, showing some long-term commitment.

5.2 Assessment of the Performance Level of the Current System of Health Services Provision and Operation among Barangay Health Offices in Surigao City

5.2.1 Type of Documents Processed Manually at the Barangay Health Office

TABLE 7.0: TYPE OF DOCUMENT PROCESSED BY BARANGAY HEALTH OFFICE

Document Process	Frequency	Percentage %
Patient registration forms	20	100%
Medical records	20	100%
Inventory management	17	85%
Reports on health services	19	95%
Manual logs	1	5%
follow-up schedule for vaccination and pre-natal	1	5%

Table 7.0 reveals that the Barangay Health Office processes a multitude of documents. A full 100% of the documents processed are Patient Registration Forms and Medical Records, suggesting frequent and efficient handling. Inventory Management and Reports on Health Services are also managed well, scoring 85% and 95%, respectively, but could benefit from further refinement. However, Manual Logs and Follow-up Schedules for Vaccination and Pre-natal, both at a mere 5%, clearly require substantial enhancement. This data underscores the need for a more balanced document processing system, with a potential call for additional resources or training in the areas that scored lower.

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5.2.2 Problems Encountered in the Manual System

TABLE 8.0: PROBLEMS ENCOUNTERED IN THE MANUAL SYSTEM

Have you encountered any problem in the manual system?	Frequency	Percentage %
Yes	17	85%
No	3	15%
Total	**20**	**100%**

Table 8.0 indicates that a significant 85% of respondents have encountered problems in the manual system, suggesting inherent issues with the manual process. Only a minor 15% have not experienced any difficulties, indicating some level of adaptability or fewer interactions with the system. This data underscores the need for improvements or a transition to a more automated system to enhance efficiency and effectiveness.

TABLE 9.0: PROBLEMS ENCOUNTERED IN THE MANUAL SYSTEM

What are the problems you have encountered?	Frequency	Percentage %
Inconsistencies in Information	20	100%
Difficulty in locating past records	20	100%
Difficulty in generating statistical reports	20	100%
Difficulty in checking previous vaccination records	20	100%
Difficulty in getting patient profiles	20	100%

Table 9.0 reveals that 100% of the respondents consistently face five key issues in the manual system such as inconsistencies in information, difficulty in locating past records, difficulty in generating statistical reports, difficulty in checking previous vaccination records, and difficulty in getting patient profiles. This indicates persistent problems in the system, underscoring the urgent need for enhancements.

5.2.3 Assessment of the Existing System of Health Services Provision and Operations among Barangay Health Offices (BHOs) in Surigao City

TABLE 10.0: THE INFLUENCING FACTORS OF THE CURRENT HEALTH SERVICES PROVISION AND OPERATIONS AMONG BARANGAY HEALTH OFFICES IN SURIGAO CITY

Factors	Question Statements	WM	Category Value	Description
Resource Availability	The current system allows for efficient delivery of health services to the community.	3.75	3.8	Agree
	The barangay health office has adequate resources (personnel, equipment, supplies) to meet the needs of the community.	3.85		
Health Services Provision	The procedure of delivering health services is clear and standardized.	3.75	4.2	Agree

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Factors	Question Statements	WM	Category Value	Description
	The training and support provided to barangay health workers, nurses, and midwives adequately prepare them to deliver effective healthcare services in the community.	4.3		
Infrastructure	The barangay office has an adequate internet connection and speed.	3.3	2.53	Moderately Agree
	The barangay office has sufficient devices (computers) for personnel use.	1.75		
Communication	The communication between the barangay health office and other healthcare providers is effective.	3.75	4.2	Agree
	The sharing of information between the local barangay health office and city health office is efficient and accurate.	4.3		
Data Security	The data collection and reporting on health services is efficient and timely.	2.85	3.05	Moderately Agree
	The data collected is placed in a secured and safe location.	3.25		

Table 10.0 reveals that the Barangay Health Offices in Surigao City consistently identified the influencing factors that affect their current health services provision and operations. The highest is Health Services Provision and Communication, both with a category value of 4.2, indicating that respondents agree on the clarity and standardization of health service delivery procedures, adequacy of training, and effectiveness of communication and information sharing. Resource Availability follows with a category value of 3.8, suggesting agreement on the efficiency of health service delivery and adequacy of resources. Data Security has a category value of 3.05, indicating moderate agreement on the efficiency and timeliness of data collection and reporting, and security of collected data. The study of Campanella et al. [4] also reveals similar challenges such as interoperability and data security that remain significant considerations in electronic health records (EHRs)adoption. Lastly, Infrastructure has the lowest category value of 2.53, showing only moderate agreement on the adequacy of internet connection and a lack of sufficient devices for personnel use. This result also similar to the findings made by Du et al. [5] wherein they have highlighted the influence of infrastructure in improving access to healthcare services and addressing disparities. Thus, this indicates persistent problems in the system, underscoring the urgent need for enhancements, particularly in infrastructure.

5.3 The Proposed Digitalization of Documents with Text Classification and Machine Learning

5.3.1The Feature and Functions of the Proposed Digitalization of Documents

Table 11.0 reveals that 100% of users agree that the proposed digitalization of documents will consistently address five key features: improving data accuracy and completeness, reducing processing time and paperwork, enhancing data accessibility and retrieval, enabling data analysis and reporting for informed decision making, and providing a user-friendly interface. Additionally, 95% of users believe it will increase transparency and accountability. This indicates the potential of the proposed system to address persistent problems and underscores the urgent need for its implementation.

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TABLE 11.0: THE FEATURE AND FUNCTIONS OF THE PROPOSED DIGITALIZATION OF DOCUMENTS

Features and Functions	Frequency	Percentage %
Improve data accuracy and completeness	20	100%
Reduce processing time and paperwork	20	100%
Enhance data accessibility and retrieval	20	100%
Enable data analysis and reporting for informed decision making	20	100%
Increase transparency and accountability	19	95%
Print out patient copies	20	100%
User friendly interface	20	100%

5.3.2 Conceptual Framework of the Proposed Digitalization of Documents with Text Classification and Machine Learning

The conceptual framework of the proposed system in Figure 1.0, the system for digitalizing documents and classifying text using machine learning begins with scanning physical documents. These scanned documents are converted into digital text using Optical Character Recognition (OCR) technology, resulting in clean, machine-readable data.

This data is then structured and stored in a database. The text data undergoes tokenization, stop word removal, and normalization to ensure consistency. Features are then extracted from the processed text for model selection similarly implemented in the works of Figueira et al. [13], Hughes et al. [14], and Liu et al. [15]. The models are trained and validated for accuracy. Finally, the outcomes of the text classification are used for analysis and insights generation.

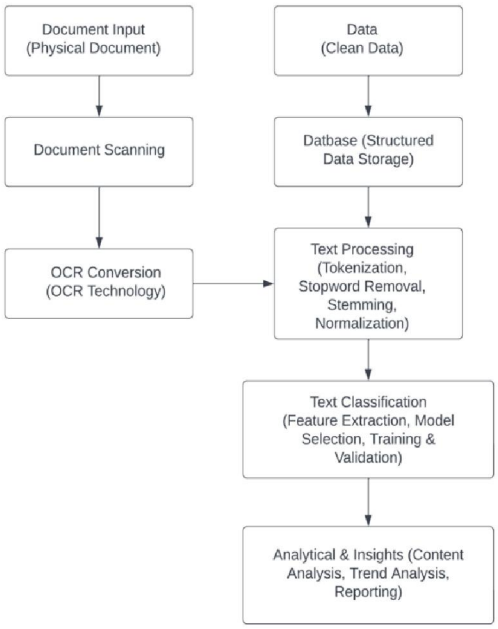

Fig. 1.Conceptual Framework of the Proposed Digitalization of Document with Text Classification and Machine Learning

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This framework provides a systematic approach to converting physical documents into analyzable digital data using OCR technology and machine learning techniques [7] [10] for text classification, highlighting the importance of clean and structured data for effective feature extraction and model training.

5.3.3 Development Architecture of the Proposed Digitalization of Documents with Text Classification and Machine Learning

Figure 2.0 showcases a robust development framework architecture designed to seamlessly convert physical documents into analyzable digital data using machine learning. It delineates a systematic process, commencing with the Document Scanning Module for digitization, followed by the Optical Character Recognition (OCR) Conversion Module to extract text from scanned images.

The Data Cleaning Module standardizes and prepares the text data for storage in a structured database facilitated by frameworks like Django or Flask. Subsequently, the Text Processing Module refines the data for machine learning tasks, while the Feature Extraction and Model Training Module trains classification models. Finally, the Analysis and Insights Generation Module employs these models for data classification and insights generation.

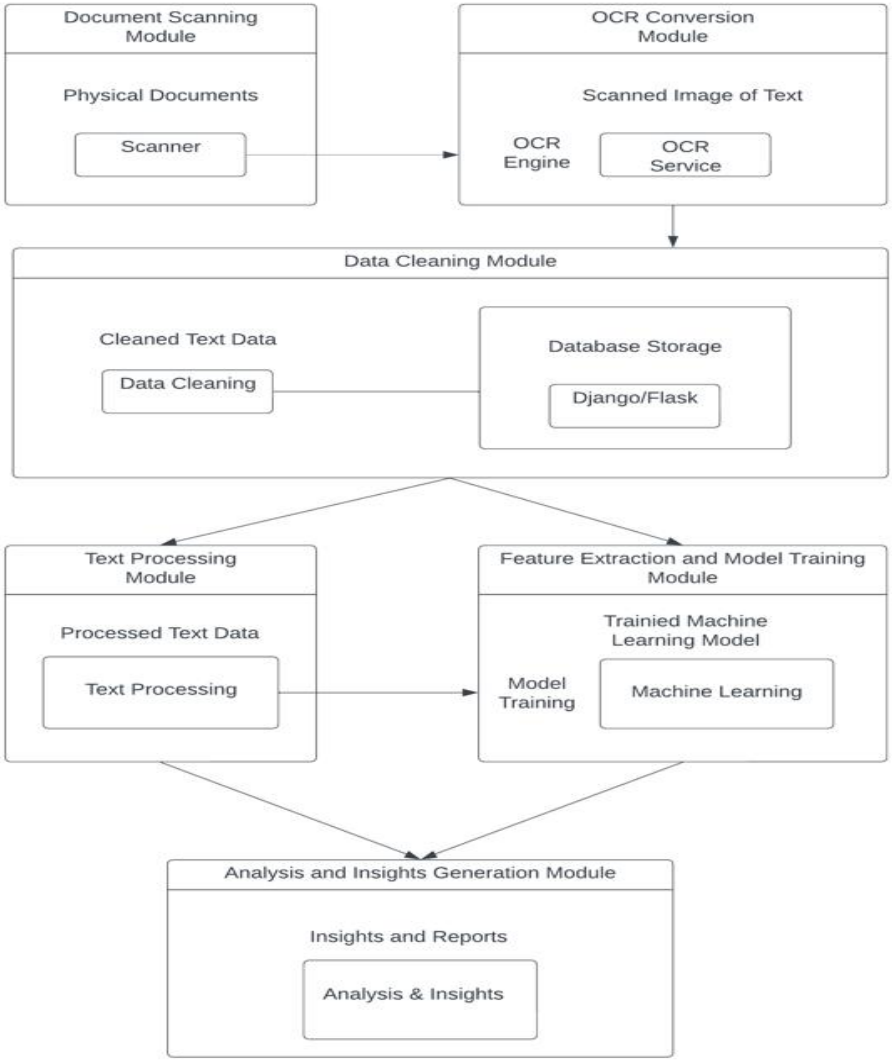

Fig.2.Development Architecture of the Proposed Digitalization of Documents with Text Classification and Machine Learning

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This architecture underscores modularity, leveraging OCR and database technologies, and incorporates agile methodologies like SCRUM for efficient project management and iterative development cycles.

5.4 Suggestions and recommendations to further enhancing and scaling up the provision of health services and operational transactions within BHOs

In response to the survey question, "Do you have any suggestions for the development of a digital framework for document reporting and analysis that would be user-friendly and efficient for barangay health offices?", only one out of 20 respondents provided feedback. The respondent acknowledged the sufficiency of the current process but highlighted that all operations are manual. This suggests an appreciation for the existing system's efficiency, but also underscores the need for digitalization to reduce manual work. However, given that this feedback is from a single respondent, it may not fully encapsulate the perspectives of all users. Therefore, additional research and more comprehensive feedback could be instrumental in developing a user-friendly and efficient digital framework tailored to the needs of barangay health offices.

VI. CONCLUSIONS AND RECOMMENDATIONS

This study evaluates the current state of health services and operations in Barangay Health Offices (BHOs) in Surigao City, focusing on document reporting and analysis. The research revealed that all health workers in the selected BHOs are female, with ages ranging from 20 to 60 years old. Overall, respondents expressed positive perceptions regarding the availability of resources, including personnel, equipment, and supplies, in the BHOs. They also indicated that the procedure for delivering health services is perceived as clear and standardized, with adequate training provided to health workers.

However, the infrastructure assessment highlighted areas for improvement, particularly in internet speed and the availability of computers. While data security measures are in place, there is room for enhancement, such as implementing data encryption and conducting regular security audits. The study proposes the implementation of an integrated system for document reporting and analysis to streamline health services provision and improve operational efficiency in BHOs.

Based on these findings, it can be concluded that while BHOs in Surigao City generally have positive perceptions of their current health services provision, there are areas for improvement, particularly in infrastructure and data security. Implementing the proposed integrated system, along with the recommendations for improving infrastructure and data security, can enhance the efficiency and effectiveness of health services delivery in BHOs.

Therefore, the following recommendations are proposed:

- Infrastructure Improvement: Enhance internet speed and ensure sufficient availability of computers in BHOs to improve operational efficiency and accessibility to digital tools.
- Data Security Enhancement: Implement data encryption, conduct regular security audits, and provide staff training on data protection protocols to ensure the security and integrity of health-related information.
- Integrated System Implementation: Implement the proposed integrated system for document reporting and analysis among BHOs in Surigao City to streamline health services provision, improve operational efficiency, and enhance data management practices.
- Continuous Evaluation and Assessment: Conduct regular evaluations and assessments of health services provision in BHOs to identify areas for continuous improvement and ensure the delivery of quality health services.
- Capacity Building: Provide ongoing training and capacity-building programs for health workers to enhance their skills and knowledge in delivering quality health services, particularly in the context of digital tools and technologies.

In conclusion, this study contributes to the existing body of knowledge by providing insights into the current state of health services provision in Barangay Health Offices in Surigao City, particularly in the context of document reporting and analysis. The findings and recommendations can serve as a valuable resource for policymakers, health administrators, and researchers seeking to improve health services delivery at the grassroots level.

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