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Research Article

Automated Fingerprint Identification System: Basis for Modernization of the Identification and Records Division (IRD)

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Abstract
The significance of fostering peace and order for sustainable development is crucial, creating an environment conducive to growth. Research in law enforcement highlights the technology gap faced by developing nations dealing with terrorism, criminal activities, and transparency challenges. While Automated Fingerprint Identification Systems (AFIS) are globally recognized for their transformative impact on criminal identification, their implementation at the National Bureau of Investigation (NBI) in the Philippines lags behind the Philippine National Police's (PNP) adoption. This study focuses on automating the NBI's fingerprint identification system to modernize the Identification and Records Division (IRD) through an explanatory sequential mixed method design, combining quantitative and qualitative analyses with a focus on IRD employees. The assessment reveals the potential of AFIS in enhancing the NBI's identification processes, database system management, and information accuracy, with overall mean scores of 4.57 for the computerized identification process, 4.56 for the computerized database system, and 4.56 for the accuracy and reliability of information, all indicating strong agreement. While AFIS offers benefits such as error reduction and improved crime-solving capabilities, challenges like image quality dependency and high implementation costs require attention. The proposed action plan, with an overall mean score of 4.66 (highly recommended), emphasizes budget allocation, IRD personnel training, and high-quality fingerprint scanning techniques to facilitate successful AFIS integration. In conclusion, the study underscores the potential benefits of AFIS in modernizing the NBI's identification processes, addressing challenges, and enhancing efficiency in law enforcement operations. The proposed action plan, supported by high mean scores, provides a structured framework for successfully implementing AFIS. Recommendations for continuous training, strategic planning, and methodical execution aim to propel the modernization of the NBI's identification and records division, ultimately improving criminal investigation and clearance issuance capabilities.
Keywords: Fingerprint Technology, Automated Fingerprint Identification System (AFIS), Law Enforcement Technology, Peace and Order, Explanatory Sequential Mixed Method Design.

1. Introduction

The foundation of sustainable development hinges on maintaining peace, and order, and an efficient criminal justice system to prevent loss of lives, property damage, and illegal activities like drug trafficking and kidnapping (Santos, 2018). Governments worldwide must empower law enforcement agencies to ensure public safety and security effectively. Law enforcement agencies globally face technological challenges in combating terrorism, and crime, and promoting governance transparency while striving to provide effective services to the public. Accurate individual identification is crucial for criminal apprehension and community protection (Wolvaard, 2007). With rapid population growth in developing countries, the adoption of identity management technologies becomes imperative to address terrorism, and crime, and manage population growth while enhancing transparency. Fingerprint identification plays a pivotal role in tracking criminals and facilitating processes like border control and license issuance (Santos, 2018). The evolution from manual to digital fingerprint techniques has led to the development of automated fingerprint identification systems (AFIS), streamlining fingerprint acquisition and matching processes for enhanced efficiency (Thales, 2023). AFIS, utilizing digital imaging for biometric identification, has revolutionized criminal identification processes globally (Thales, 2023). Integrating AFIS into the operations of the National Bureau of Investigation (NBI) aligns with modernization efforts mandated by the NBI Reorganization and

Modernization Act of 2016, aiming to enhance crime investigation and clearance issuance (Thales, 2023). This integration facilitates a higher volume of fingerprint checks, improving matching processes and overall operational efficiency. While the Philippine National Police (PNP) has successfully implemented AFIS, the NBI has yet to adopt this technology, despite its crucial investigative role (ph.nec.com).

The NBI's Identification and Records Division (IRD) currently operates a manual fingerprinting system, hindering the efficient processing of clearance applicants and matching civilian fingerprints with criminal records. The NBI Reorganization and Modernization Act of 2016 pave the way for modernizing NBI operations through advanced equipment and forensic laboratories (Supreme Court E-Library, 2016). The significance of the automated fingerprint identification system (AFIS) in biometric identification technology cannot be understated, with its evolution streamlining the fingerprint identification process and enhancing public safety measures (Rouse, 2012). The study's framework is rooted in Section 4 (m) of Republic Act No. 10867, also known as the "National Bureau of Investigation (NBI) Reorganization and Modernization Act of 2016", mandating the establishment of a modern NBI Clearance and Identification Center encompassing derogatory and criminal records, civilian identification records, identifying marks, characteristics, fingerprint database, and dental records as per Presidential Decree No. 1575, titled "Requiring Practitioners of Dentistry to Keep Records of Their Patients". This study aims to explore the automation of the fingerprint identification system of the National Bureau of Investigation as a foundation for the modernization of its identification and records division (IRD). Specifically, it seeks to address the following research questions: How is the automation of the fingerprint identification system of the National Bureau of Investigation (NBI) in terms of the computerized identification process; computerized database system; and accuracy and reliability of information? What are the perceived advantages of automating the fingerprint identification system of the National Bureau of Investigation (NBI) concerning the variables mentioned above? What are the obstacles in automating the fingerprint identification system in the identification and records (IRD) of the National Bureau of Investigation? What action plan can be developed to propose an AFIS section for the modernization of fingerprint files and records at NBI?

2. Methodology

The study utilized an explanatory sequential mixed method design following the guidelines from Harvard Catalyst (2023). The methodology involved a sequential process, beginning with quantitative data collection and analysis, followed by qualitative data collection and analysis to assess the reliability and accuracy of the automated fingerprint identification system. Quantitative research focuses on numerical data analysis using statistical techniques, while qualitative research explores real-world issues to provide in-depth insights into participants' experiences and perceptions. This comprehensive approach allowed for a thorough understanding of the automation of the fingerprint identification system at the National Bureau of Investigation (NBI) headquarters in Taft Avenue, Manila, for modernizing the identification and records division (IRD).

The study population included NBI employees within the identification and records division, and data collection adhered to the Bureau's Data Privacy Act through a convenient sampling scheme. Established in 1936, the NBI operates under the Department of Justice, handling major cases of national interest. The study employed a self-structured survey questionnaire to address the automation of the fingerprint identification system, its advantages, and hindrances in the NBI's identification and records. The methodology also involved the validation of the instrument by experts in the automated fingerprint identification system (AFIS) and the thesis adviser, ensuring the variables' clarity, objectivity, and relevance to the research problem.

The data-gathering procedure included seeking permission, validating survey instruments, distributing and collecting questionnaires, and analyzing results using a ranking method. The Explanatory sequential design in data analysis integrated quantitative findings to guide qualitative exploration, with content and axial coding used for data interpretation. Ethical considerations were paramount, with the researcher securing permission from the PCCR's graduate studies department and participants, ensuring voluntary participation and data confidentiality. The study was conducted without experimental interventions, and incomplete data were excluded from analysis to uphold ethical standards and research integrity.

3. Results and Discussion

This study aimed to explore the automation of the fingerprint identification system of the National Bureau of Investigation as a foundation for the modernization of its identification and records division (IRD), addressing research questions on the automation process, advantages, obstacles, and proposing an action

plan for implementing an AFIS section for the enhancement of fingerprint files and records at NBI. The results and their corresponding discussion are as follows:

3.1. AFIS in Terms of the Computerized Identification Process

Table 1 shows a notable consensus among respondents across all indicators concerning the computerized identification process, signifying a high level of agreement throughout the study. The mean scores, ranging from 4.43 to 4.79, consistently reflect a positive perception of the evaluated indicators. Specifically, efficiency and timeliness received a mean score of 4.44, emphasizing the strong agreement on AFIS's proficiency in swift and effective matching against a large database for timely responses. The identification process was highly rated at 4.56, showcasing a firm agreement on AFIS's expertise in identifying criminal suspects. Additionally, data processing scored 4.43, highlighting agreement on AFIS's effectiveness in processing fingerprint images for characteristic information. The automated search achieved a mean score of 4.57, indicating concurrence with AFIS's efficiency in searching databases for candidate matches. Furthermore, positivity and reliability, scoring 4.57, underscored agreement on AFIS's provision of a positive and reliable identity for suspects. Cost effectiveness obtained a notable mean score of 4.59, affirming consensus on AFIS's potential for cost savings and enhanced identification processes. Moreover, technology advancement and biometric integration received high scores of 4.43 and 4.71, respectively, indicating agreement on advanced algorithms and multi-modal biometrics integration. Real-time identification scored the highest at 4.79, reflecting strong agreement on AFIS's real-time identification capabilities. The overall mean of 4.57 encapsulates the collective sentiment of strong agreement, reflecting a positive perception of AFIS's efficacy and efficiency in the study's evaluated aspects. The findings indicate a strong consensus on the effectiveness of AFIS in enhancing various aspects of the computerized identification process, with consistently high mean scores across all indicators. The positive reception of AFIS's capabilities, particularly in efficiency, timeliness, and real-time identification, suggests that the system is well-regarded for its potential to modernize and improve law enforcement operations.

Table 1. Computerized identification process of NBI's AFIS.

Indicators	Mean	Descriptive interpretation
Real-time identification	4.79	Strongly agree
Biometric integration	4.71	Strongly agree
Identification process	4.56	Strongly agree
Cost effectiveness	4.59	Strongly agree
Automated search	4.57	Strongly agree
Positivity and reliability	4.57	Strongly agree
Efficiency and timeliness	4.44	Strongly agree
Data processing	4.43	Strongly agree
Technology advancement	4.43	Strongly agree
Overall mean	**4.57**	**Strongly agree**

These results are consistent with prior research by Santos (2018), Tubid (1996), and Rouse (2012), which emphasize AFIS's crucial role in real-time identification and enhancing law enforcement processes. Looking ahead, continued enhancements in AFIS are anticipated to further enhance the efficiency and accuracy of identification processes for law enforcement agencies, ensuring improved outcomes in crime prevention and investigation. Considering the National Bureau of Investigation's status as the country's premier investigative agency, the adoption of AFIS is expected to significantly aid in combating criminal activities due to its real-time identification capabilities in identifying reliable and accurate matches of fingerprints under scrutiny. This capability may contribute to the swift response of law enforcement to criminal activities and improve the overall identification process, thereby offering a positive and dependable identification of criminal suspects, as evidenced by the respondents' feedback.

3.2. AFIS in Terms of a Computerized Database System

In table 2, the mean scores for each indicator, ranging from 4.34 to 4.71, reflect a high level of agreement and positive perception toward the functionalities of the automated fingerprint identification system (AFIS) evaluated in terms of computerized database system. Specifically, the indicators of data storage, security procedures, fingerprint matching, history information, real-time identification, centralized database creation, accuracy in identification, criminal record management, and scalability all received mean scores indicating a strong consensus and a high degree of agreement among respondents, with ratings falling within the "strongly agree" category. While the indicator of information accuracy scored slightly lower at 4.34, it still falls within the "agree" category, indicating that respondents generally agreed with the system's

information accuracy. The overall mean of 4.56 further supports the collective sentiment of strong agreement across all indicators, highlighting the positive perception toward the effectiveness and efficiency of AFIS in various aspects assessed in the study.

Table 2. Computerized database system of NBI's AFIS.

Indicators	Mean	Descriptive interpretation
Centralized database creation	4.71	Strongly agree
Security procedures	4.64	Strongly agree
Scalability	4.64	Strongly agree
Criminal record management	4.61	Strongly agree
Real-time identification	4.60	Strongly agree
Accuracy in identification	4.56	Strongly agree
Data storage	4.54	Strongly agree
Fingerprint matching	4.46	Strongly agree
History information	4.46	Strongly agree
Information accuracy	4.34	Agree
Overall mean	**4.56**	**Strongly agree**

The results affirm AFIS's effectiveness in centralizing fingerprint databases, maintaining database security, and accurately identifying individuals based on fingerprints, further enhancing collaboration and information sharing among law enforcement agencies for efficient crime prevention and investigation. The study also revealed that the NBI's current database falls short of the capabilities of AFIS. Automating the AFIS is expected to enhance the database system for both criminals and non-criminals, aligning with Santos's (2018) findings on AFIS's ability to manage a substantial number of records for national or international identification systems.

The evolution of AFIS technology has extended its applications beyond law enforcement to various government and private entities due to heightened security concerns. AFIS not only enables law enforcement to conduct a larger volume of fingerprint checks but also plays a crucial role in comparing latent prints with known suspects' fingerprints. Developed in response to the need for efficient fingerprint identification in the late 1960s and early 1970s, AFIS has become a vital tool in biometric identification. The system's highly automated workflow processes and scalability make it adaptable to databases of varying sizes. Studies have shown AFIS's effectiveness in achieving high recognition rates and its significance in criminal and disaster victim identification. The theoretical framework of the study is based on the advantages of AFIS in modernizing the NBI Clearance and Identification Center as mandated by Republic Act No. 10867, emphasizing the system's role in computerized identification, database systems, and information accuracy.

3.3. AFIS in Terms of Reliability and Accuracy of Information

Table 3. Reliability and accuracy of NBI's AFIS.

Indicators	Mean	Descriptive interpretation
Timeliness and accuracy of information	4.71	Strongly agree
Interfacing capability	4.64	Strongly agree
Crime statistics accuracy	4.63	Strongly agree
Global success track record	4.57	Strongly agree
Reliability and accuracy	4.49	Strongly agree
Operational consistency	4.49	Strongly agree
Consistency in results	4.46	Strongly agree
Centralized data management	4.46	Strongly agree
Overall mean	**4.56**	**Strongly agree**

In table 3, the mean scores for each indicator, ranging from 4.46 to 4.71, demonstrate a high level of agreement and positive perception towards the functionalities of the automated fingerprint identification system (AFIS) evaluated according to reliability and accuracy. Specifically, indicators such as crime statistics accuracy, timeliness and accuracy of information, interfacing capability, and global success track record all received mean scores indicating a strong consensus and a high degree of agreement among respondents, falling within the "strongly agree" category. Additionally, indicators such as reliability and accuracy, consistency in results, operational consistency, and centralized data management also scored positively,

further reinforcing the strong agreement and positive perception towards the various aspects of AFIS functionality. The overall mean of 4.56 supports the collective sentiment of strong agreement across all indicators, reflecting a positive perception toward the reliability, accuracy, and operational efficiency of AFIS in the study's evaluation. AFIS's success in providing accurate statistics, timely information on criminals, and maintaining a worldwide track record underscores its effectiveness in ensuring consistent and reliable identification results. The centralized storage of fingerprint data by AFIS contributes to reliability by ensuring up-to-date and consistent records.

Overall, the results affirm AFIS's credibility and efficiency in providing accurate information for law enforcement purposes. Respondents emphasized AFIS's crucial role in timely and accurate identification, leading to swift investigation resolutions. Santos (2018) also confirmed AFIS's consistent and reliable performance, surpassing human operators in the identification process.

The evolution of AFIS technology has broadened its applications beyond law enforcement to various government and private entities due to heightened security concerns. AFIS's capacity to conduct a larger volume of fingerprint checks, particularly in comparing latent prints with known suspects' fingerprints, represents a significant advancement. Developed in response to the demand for efficient and precise fingerprint identification in the late 1960s and 1970s, AFIS has become a crucial tool in biometrics identification, with leading countries like the United States and Japan spearheading research into automated fingerprint identification systems. Moreover, AFIS interfaces offer automated workflow processes and scalable systems capable of managing databases of varying sizes. Studies have showcased AFIS's effectiveness in achieving high recognition rates and its vital role in criminal and disaster victim identification. The study's theoretical framework centers on establishing a modern NBI Clearance and Identification Center by Republic Act No. 10867, highlighting AFIS's advantages in computerized identification, database systems, and information accuracy.

3.4. Perceived Advantages of NBI's AFIS in Terms of Computerized Identification Process

Table 4 illustrates the perceived advantages of the computerized identification process of NBI's AFIS. The mean scores for each indicator, ranging from 4.46 to 4.71, demonstrate a high level of agreement and positive perception toward the perceived advantages of the AFIS system evaluated in the study. Each indicator received a rating falling within the "strongly agree" category, indicating a strong consensus among respondents regarding the benefits of the computerized identification process.

Specifically, indicators such as minimization of human error, accuracy in fingerprint analysis, and database management garnered the highest mean scores, with ratings of 4.71, 4.63, and 4.64, respectively, emphasizing the strong agreement on the effectiveness and efficiency of the AFIS system in these aspects. Other indicators such as swift identification, quick retrieval, crime prevention, forensic investigations, and automation efficiency also received high mean scores, further reinforcing the positive perception towards the advantages offered by the computerized identification process of NBI's AFIS. The overall mean of 4.56 across all indicators signifies a collective sentiment of strong agreement among respondents, reflecting the positive perception towards the advantages and benefits provided by the AFIS system in enhancing the identification processes at the National Bureau of Investigation. The top-rated items emphasize AFIS's ability to quickly compare fingerprints, analyze intricate patterns with high accuracy, manage large databases, facilitate rapid record retrieval, and contribute to crime prevention through swift identification of individuals with criminal histories. AFIS's pivotal role in law enforcement and forensic investigations streamlines identification and comparison processes, ultimately reducing manual labor and time-consuming tasks.

Table 4. Perceived advantages of the computerized identification process of NBI's AFIS.

Indicators	**Mean**	**Descriptive interpretation**
Swift identification	4.49	Strongly agree
Minimization of human error	4.71	Strongly agree
Database management	4.64	Strongly agree
Accuracy in fingerprint analysis	4.63	Strongly agree
Quick retrieval	4.57	Strongly agree
Forensic investigations	4.49	Strongly agree
Crime prevention	4.46	Strongly agree
Automation efficiency	4.46	Strongly agree
Overall mean	**4.56**	**Strongly agree**

These results affirm the reliability and efficiency of AFIS in optimizing the computerized identification process for various applications, including law enforcement and immigration. The implementation of AFIS is anticipated to greatly benefit NBI investigators by providing an accurate and efficient system, leading to quicker resolutions for assigned cases. These findings align with Santos's (2018) research, highlighting AFIS's automation in the computerized identification processes that eliminates human fatigue and biases, ensuring consistent and reliable outcomes. AFIS's proficiency in managing extensive fingerprint databases further enhances its effectiveness in identification processes. The evolution and significance of AFIS technology extend beyond law enforcement to various government and private sectors, addressing escalating security concerns (Rouse, 2012). Notable advancements in biometric identification are evident in AFIS's capability to handle a larger volume of fingerprint checks, especially in comparing latent prints with known suspects (Santos, 2018). Additionally, AFIS interfaces offer automated workflow processes and scalable systems that can manage databases of varying sizes (NEC, 2015). The critical role of AFIS in criminal and victim identification, with high recognition rates, is supported by research. Emphasizing the benefits of AFIS in computerized identification, database systems, and information accuracy, the study's theoretical framework underscores the necessity of establishing a modern NBI Clearance and Identification Center as mandated by Republic Act No. 10867 (Tubid, 1996; Rouse, 2012; Santos, 2018).

3.5. Perceived Advantages of NBI's AFIS in Terms of Computerized Database System

Table 5 reveals the perceived advantages of the computerized database system of NBI's AFIS. The mean scores for each indicator, ranging from 4.34 to 4.71, demonstrate a high level of agreement and positive perception towards the perceived advantages of the AFIS system evaluated in the study. Each indicator received a rating falling within the "strongly agree" category, indicating a strong consensus among respondents regarding the benefits of the computerized database system.

Specifically, indicators such as assistance in forensic analysis and reduction of human error garnered the highest mean scores, with ratings of 4.71 and 4.54, respectively, emphasizing the strong agreement on the effectiveness and efficiency of the AFIS system in these aspects. Other indicators such as role in crime solving, efficient data storage and retrieval, precision in matching algorithms, and cost savings also received high mean scores, further reinforcing the positive perception towards the advantages offered by the computerized database system of NBI's AFIS.

The overall mean of 4.51 across all indicators signifies a collective sentiment of strong agreement among respondents, reflecting the positive perception towards the benefits and advantages provided by the AFIS system in enhancing the database management processes at the National Bureau of Investigation.

Table 5. Perceived advantages of the computerized database system of NBI's AFIS.

Indicators	Mean	Descriptive interpretation
Assistance in forensic analysis	4.71	Strongly agree
Reduction of human error	4.54	Strongly agree
Role in crime solving	4.53	Strongly agree
Efficient data storage and retrieval	4.51	Strongly agree
Precision in matching algorithms	4.40	Strongly agree
Cost savings	4.34	Strongly agree
Overall mean	**4.51**	**Strongly agree**

The top-rated items emphasize AFIS's advanced matching algorithms, its significant contribution to crime-solving through fingerprint matching, the automation that reduces human error, the efficiency in storing and retrieving fingerprint data, and its support to forensic experts in analyzing latent fingerprints. The potential cost savings of AFIS in streamlining processes and reducing manual labor in fingerprint analysis are also acknowledged.

The study further highlights that a larger database system enables quicker comparison of fingerprints, expediting the elimination process in criminal investigations. These findings are consistent with Dror's (2009) assertion that AFIS plays a crucial role in crime-solving by matching fingerprints from crime scenes with those in criminal databases, while also reducing the potential for human error in the identification process. AFIS's capabilities in enhancing forensic analysis and expediting crime-solving processes underscore its vital role in modern investigative practices. Specifically, indicators such as assistance in forensic analysis and reduction of human error garnered the highest mean scores, with ratings of 4.71 and 4.54, respectively, emphasizing the strong agreement on the effectiveness and efficiency of the AFIS system in

these aspects. Other indicators such as role in crime solving, efficient data storage and retrieval, precision in matching algorithms, and cost savings also received high mean scores, further reinforcing the positive perception towards the advantages offered by the computerized database system of NBI's AFIS.

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3.6. Perceived Advantages of NBI's AFIS in Terms of Accuracy and Reliability of Information

Table 6. Perceived advantages of the accuracy and reliability of information of NBI's AFIS.

Indicators	Mean	Descriptive interpretation
Flexible search options	4.56	Strongly agree
Standardized algorithms	4.54	Strongly agree
Historical data storage	4.43	Strongly agree
Integration into criminal justice systems	4.40	Strongly agree
Quick processing of large databases	4.36	Strongly agree
Legal acceptance of results	4.29	Strongly agree
Overall mean	**4.43**	**Strongly agree**

Table 6 indicates the perceived advantages of the accuracy and reliability of information from NBI's AFIS. The mean scores for each indicator, ranging from 4.29 to 4.56, indicate a high level of agreement and positive perception toward the accuracy and reliability of information provided by the AFIS system evaluated in the study. Each indicator received a rating falling within the "strongly agree" category, showcasing a strong consensus among respondents regarding the benefits of the system.

Specifically, indicators such as flexible search options and standardized algorithms received high mean scores, with ratings of 4.56 and 4.54, respectively, emphasizing the strong agreement on the system's capability to provide flexible search options and utilize standardized algorithms effectively. Other indicators such as historical data storage, quick processing of large databases, integration into criminal justice systems, and legal acceptance of results also received favorable mean scores, further reinforcing the positive perception towards the accuracy and reliability of information provided by the AFIS system.

The overall mean of 4.43 across all indicators signifies a collective sentiment of strong agreement among respondents, reflecting the positive perception towards the accuracy and reliability of information facilitated by the AFIS system at the National Bureau of Investigation. The top-rated items underscore AFIS's adaptability in search options, integration into larger criminal justice systems for seamless data sharing, storage and retrieval of historical fingerprint data, quick processing of large fingerprint databases for swift identification, and the use of standardized algorithms for accuracy and error reduction. The overall mean score of 4.43 indicates strong agreement with the effectiveness and reliability of AFIS in providing precise and trustworthy information for diverse applications, including law enforcement and forensic analysis. Respondents highlighted AFIS's significant advantage in enabling searches for potential matches even with suboptimal fingerprint image quality, a task that manual processes struggle to accomplish effectively. With advanced fingerprint recognition algorithms, AFIS can efficiently and accurately match fingerprints against extensive databases, establishing it as a preferred tool for law enforcement agencies and various sectors. This observation aligns with Santos's (2018) assertion that AFIS has notably enhanced crime- solving capabilities, enabling rapid searches of vast databases. The operational workflow involves matching prints, latent prints, and unresolved fingerprints, streamlining investigative procedures,

and augmenting forensic capabilities. The integration of AFIS across solution boundaries offers highly automated workflow processes, further solidifying its utility in multiple sectors.

3.7. Assessment of the Hindrances in the Automation of the Fingerprint Identification System

Table 7 displays the perceived hindrances of the automation of the fingerprint identification system (FIS). The mean scores for each indicator, ranging from 4.29 to 4.71, suggest a strong level of agreement and shared concern regarding the challenges associated with the automation of the FIS system. Each indicator received a rating falling within the "strongly agree" category, indicating a consensus among respondents on the identified hindrances.

Specifically, indicators such as dependency on image quality and cost of implementation received the highest mean scores, with ratings of 4.71 and 4.57, respectively, highlighting the significant impact of image quality and costs on the successful automation of the FIS. Resource intensiveness and privacy and security challenges also received high mean scores, emphasizing the perceived challenges related to managing resources and ensuring data privacy and security in the automated system. The indicator of need for trained personnel, while slightly lower in the mean score at 4.29, still indicates a strong agreement on the importance of skilled personnel for effective FIS operation.

Table 7. Perceived hindrances of the automation of the FIS.

Indicators	Mean	Descriptive interpretation
Dependency on image quality	4.71	Strongly agree
Cost of implementation	4.57	Strongly agree
Resource intensiveness	4.54	Strongly agree
Need for trained personnel	4.29	Strongly agree
Privacy and security challenges	4.46	Strongly agree
Overall mean	**4.51**	**Strongly agree**

The overall mean of 4.51 across all indicators signifies a collective sentiment of strong agreement among respondents, reflecting the acknowledgment of the hindrances associated with the automation of the fingerprint identification system. These results underscore the importance of addressing these challenges to ensure the successful implementation and operation of the automated FIS system.

Respondents highlight the crucial role of image quality in influencing the accuracy of AFIS, underscoring the impact of poor-quality images on identification precision. Additionally, the recognition of the potential expenses and resource intensiveness in implementing and maintaining an automated fingerprint identification system underscores the strategic financial planning required for such technologies. The proficient use of FIS necessitates skilled technical personnel well-versed in the technology and its operational boundaries. These insights align with Dror's (2009) research, suggesting that the utilization of large databases and the execution of multiple comparisons demand adaptations and adjustments in the threshold criteria for identification, emphasizing the evolving nature of identification processes in forensic contexts.

3.8. Measures or Action Plan Proposing AFIS Section for the Modernization of Fingerprint Files and Records of NBI

Table 8. Measures or action plan.

Indicators	Mean	Descriptive interpretation
Training prioritization	4.71	Highly recommended
Budget allocation	4.71	Highly recommended
Quality assurance in equipment	4.57	Highly recommended
Personnel hiring	4.54	Highly recommended
Establishment of identification center	4.50	Highly recommended
Training and qualification requirements	4.43	Highly recommended
Facility improvement	4.34	Highly recommended
Compliance with data standards	4.34	Highly recommended
Legal and ethical compliance	4.34	Highly recommended
System auditing	4.34	Highly recommended
Overall mean	**4.55**	**Highly recommended**

The top 5 results in Table 8 highlight crucial recommendations for the National Bureau of Investigation (NBI) to enhance its Identification and Records Division (IRD) through the implementation of the Automated Fingerprint Identification System (AFIS). The highest- rated recommendations include the allocation of budget for AFIS equipment procurement (4.71), prioritizing AFIS training for IRD personnel (4.71), ensuring high-quality fingerprint scanning standards (4.57), establishing a modern NBI identification center (4.5), and hiring additional AFIS experts (4.54). These recommendations emphasize the importance of investing in technology, training, and infrastructure to modernize and improve the efficiency of the IRD.

The top five items with the highest mean scores highlight the importance of budget allocation for AFIS equipment, hiring additional expert personnel, requiring necessary criminology degree for existing staff, prioritizing AFIS training for IRD personnel, and establishing a state-of-the-art network of equipment and facilities to enhance the IRD and comply with the NBI Modernization Act. The item with the lowest mean recommends ensuring compliance with legal and ethical standards in the use and release of personal information. The overall mean score of 4.55 indicates a strong recommendation for the proposed measures to automate the NBI's fingerprint system effectively.

Usmani *et al.,* (2013) discussed the increasing utility and cost-effectiveness of fingerprint identification systems, emphasizing the importance of budget allocation to meet technical challenges. The study's results echo the need for agencies to allocate funds for AFIS equipment procurement. This aligns with the evolution of AFIS technology, which has expanded beyond law enforcement to address security concerns. AFIS's efficiency in conducting rapid and accurate fingerprint checks, as well as its continuous development to enhance identification accuracy, are key points highlighted in the study. Additionally, the study underscores the pivotal role of AFIS in law enforcement operations, as recognized by the Philippine National Police, emphasizing its significance in criminal identification and disaster victim identification. The alignment of these proposed measures with the recommendations from Usmani *et al.,* (2013) and the practical applications within law enforcement further solidify the importance of investing in AFIS technology for efficient and reliable fingerprint identification processes.

3.9. Proposed Action Plan for the Establishment of an Automated Fingerprint System (AFIS) within the National Bureau of Investigation (NBI)

Table 9. Proposed action plan.

Objective/goal	**Establishment of AFIS in the National Bureau of Investigation**		
Implementation strategies	**Time frame**	**Responsible agency/office**	**Estimated budget**
1. Allocation of budget/ funding	From May 2024 to May 2030	NBI: Directorial staff (including budget officers) Identification and records division	Phase 1: 500,000,000.00 Phase 2: 500,000,000.00 Phase 3: 500,000,000.00 Phase 4: 500,000,000.00
2. Provision of international and national seminars, trainings, workshops about AFIS	From May 2024 to May 2030	Registered criminologist Investigators AFIS experts	1,500,000.00
3. Inter-agency collaboration	From May 2024 to May 2030	FBI PNP Bureau of immigration among others	500,000.00
4. Employment of registered criminologists	From May 2024 to May 2030	NBI Human resource management division (HRMD)	6,700,000.00
5. Acquisition of modern equipment (e.g., fingerprint kit, scanners, printers, copiers, and other state of the art equipment)	From May 2024 to May 2030	NBI budget division Procurement Management division office of the comptroller service	50,000,000.00

To achieve the goal of establishing AFIS, the action plan includes several key implementation strategies. These strategies encompass a comprehensive budget allocation totaling PHP 2 billion over four (4) phases from May 2024 to May 2030. The responsible allocation of sources is crucial for the successful implementation of the AFIS project, with specific responsibilities assigned to key personnel within the NBI, including the Director, Directorial Staff, Budget Officers, and the IRD. Additionally, training initiatives are planned for criminologists, investigators, and AFIS experts, with an estimated budget of PHP 1.5 million allocated to ensure the workforce is equipped with the necessary skills and knowledge to operate the AFIS effectively. This is spearheaded by the IRD in coordination with the NBI Training Division and the Assistant Director of the Human Resource Management Service (OADHRMS).

Moreover, the action plan emphasizes inter-agency collaboration as vital to the project's success. Collaboration with external entities such as the Federal Bureau of Investigation (FBI), Philippine National Police (PNP), and other relevant agencies is planned to enhance information sharing, coordination, and joint efforts in combating crime effectively. The budget allocation for inter-agency collaboration is set at PHP 500,000 to facilitate seamless cooperation and communication among law enforcement bodies. Additionally, the recruitment of skilled professionals is prioritized, with an estimated budget of PHP 6.7 million earmarked for hiring registered criminologists to support the implementation and operation of the AFIS. Furthermore, equipment acquisition is critical to the action plan to ensure the AFIS operates efficiently. The NBI Budget Division is tasked with procuring modern equipment necessary for the AFIS, with an estimated budget of PHP 50 million allocated for this purpose. This investment in advanced technology and equipment is essential to enhance the NBI's operational capabilities and improve crime-solving efficiency. The discussion aligns with the evolution of AFIS technology and its expansion beyond law enforcement to address security concerns. AFIS's ability to conduct efficient fingerprint checks and its development in response to the need for accurate identification are key points emphasized in the study. Additionally, the importance of AFIS in law enforcement operations, as highlighted by the PNP, underscores the system's significance in criminal identification and disaster victim identification. The study's results echo the need for agencies to allocate funds for AFIS equipment procurement. Usmani *et al.,* (2013) discussed the increasing utility and cost-effectiveness of fingerprint identification systems, emphasizing the importance of budget allocation to meet technical challenges.

Overall, the meticulous planning and phased approach outlined in the action plan aims to ensure the successful implementation of the AFIS platform at the NBI, leading to strengthened law enforcement capabilities and enhanced crime-solving efficiency.

4. Conclusions and Recommendations

The study on the automation of the fingerprint identification system at the National Bureau of Investigation (NBI) has revealed significant positive outcomes. The Automated Fingerprint Identification System (AFIS) demonstrated excellence in both the computerized identification process and the computerized database system, showcasing capabilities such as real-time identification, multi-modal biometrics integration, and centralized fingerprint databases.

Additionally, AFIS has improved law enforcement operations by providing timely and accurate criminal information, contributing to enhanced efficiency and accuracy in criminal investigations. The perceived advantages of automating the system cover critical areas like reducing human error, managing extensive databases, supporting forensic analysis, and enhancing information retrieval accuracy through versatile search options and standardized algorithms.

The study offers several key recommendations to enhance the capabilities of the National Bureau of Investigation (NBI) through the integration of Automated Fingerprint Identification System (AFIS) technology. Building on the positive outcomes observed, it is recommended to further embed AFIS into the NBI's operational processes to improve crime-solving capabilities and boost law enforcement efficiency.

To fully realize the benefits of AFIS, continuous training for Identification and Records Division (IRD) personnel is essential, with a focus on reducing human error, enhancing database management skills, and optimizing the accuracy of information retrieval.

Strategic planning should address challenges such as image quality dependency, system costs, and the resource-intensive nature of database management, with the goal of streamlining processes and identifying cost-effective solutions. Additionally, the implementation of the proposed action plan for

modernizing fingerprint files and records at the NBI is critical. This should include prioritizing adequate training and quality assurance in fingerprint scanning techniques to enhance investigative services and align with global standards, ultimately positioning the NBI as a leading investigative institution.

Declarations

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