

A DNA Biometric Implementation Model to Promote Thailand's Criminal Justice System

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ABSTRACT

DNA biometrics has proven to be a valuable tool in criminal justice systems worldwide, providing accurate identification and helping solve crimes effectively. However, Thailand faces several challenges in implementing DNA biometrics in its criminal justice system. This study aimed to explore the use of DNA as reliable biometric data in Thailand's judicial and authentication processes, develop operational procedures for practical use, identify problems and obstacles, and propose a suitable model for implementation. The study employed documentary research and in-depth interviews with sixteen experts in the criminal justice system. The findings revealed that the absence of a central authority for collecting DNA biometric data results in disparate management of DNA databases and a lack of coordination between agencies. Personnel and budget issues, insufficient professional standards for forensic science officers, and the absence of a central agency responsible for forensic science work management also hinder Thailand's forensic science operations. Issues related to crime scene protection, such as the lack of operational guidelines for collecting evidence and insufficient first-response units, were also identified. Furthermore, Thai judges often lack sufficient knowledge to assess the reliability of forensic evidence. Another major obstacle is the absence of a law to establish a central agency that administers the National DNA Database. The study proposes the establishment of a central agency to oversee the collection and management of DNA biometric data, the development of clear operational guidelines, and the provision of training for personnel involved in the criminal justice system to effectively implement DNA biometrics in Thailand.

Keywords: Biometrics; Criminal justice; DNA database; Forensic science; Laws

1. Introduction

All individuals have unique DNA, with the exception of identical twins. This fact is central to DNA analysis, which uses DNA samples to identify individuals. It has helped many countries effectively solve and suppress crime by increasing the ability of law enforcement to identify suspects [1]. It is also helpful in identifying persons and proving blood relationships, such as paternity and maternity relationships or relatives [2]. As a trace left at a crime scene, DNA is also essential in identifying offenders, per Locard's exchange principle [3, 4]. This is especially true for the DNA testing of touched objects (touch DNA) [5, 6].

Short Tandem Repeats (STRs) are widely used as DNA markers to establish personal identity [7, 8] as they provide numerical results that can be easily interpreted and used as evidence in criminal cases. These results suit biometric data, which utilizes biological data for identification through a combination of biological and computer technologies [9]. Many countries have recognized the benefits of using DNA as biometric data for identification, leading to the establishment of national DNA databases for criminal justice purposes [10].

Recent developments in Next-Generation Sequencing (NGS) have significantly transformed forensic DNA analysis, offering faster, more accurate, and more comprehensive results than traditional STR-based methods [11]. NGS enables simultaneous analysis of various genetic markers, including mitochondrial DNA, SNPs, and STRs, allowing improved identification from degraded samples or complex mixtures [12]. These capabilities enhance forensic investigations, especially in cases involving disaster victim identification or ancient DNA analysis

[13].

Since 1998, the United States has used DNA databases to assist in solving more than 700,000 criminal cases [14], making it one of the most effective tools available. However, the debate on expanding the database to collect DNA from all populations has been abandoned, owing to operational and personal liberty concerns [15]. One study showed that DNA databases can reduce recidivism among past offenders, decrease crime rates, and are more cost-effective than traditional justice processes [16]. DNA databases are widely used globally, and many countries have established national databases. Although Thailand has not yet established a national DNA database, the criminal justice system has successfully utilized DNA evidence in important criminal cases [17].

Initially developed by the FBI, the Combined DNA Index System (CODIS) has gained substantial global adoption and now facilitates cross-border collaboration in criminal investigations. Many countries have adopted CODIS software to align with international forensic standards and participate in information-sharing protocols that enhance the tracking of suspects and repeat offenders [18]. The expansion of CODIS has contributed to creating interoperable databases and increased the capacity to link crime scene DNA to individuals across jurisdictions, supporting the global fight against transnational crime [19].

As DNA databases become more prevalent, concerns about genetic privacy and data protection have intensified, especially in jurisdictions governed by strict privacy regulations such as the European Union's General Data Protection Regulation (GDPR) [20]. DNA data, being highly sensitive and uniquely identifiable, raises ethical and legal questions about consent,

data retention, third-party access, and misuse.

Recently, Thailand signed a Memorandum of Understanding with the United States of America to use the CODIS software system to collect and search for DNA data stored in the national DNA database of the United States [21]. Thailand must amend regulations regarding the authority of government officers to collect DNA samples from the accused or defendant in criminal cases to establish a National DNA Database.

This study aimed to explore using DNA as reliable biometric data in Thailand's judicial and authentication processes. It aimed to develop operational procedures that effectively use DNA biometrics, possibly leading to further law drafting. This study also aimed to identify problems and obstacles in using DNA biometrics in the Thai criminal justice system and to propose a suitable model for its use.

1.1 Literature review: theoretical frameworks related to dna databases

The deployment of national DNA databases is underpinned by multiple theoretical frameworks that explain their impact on crime control, particularly recidivism, as well as broader social and legal implications. Among the most relevant are Deterrence Theory, Surveillance Theory, and Human Rights Theories. Deterrence Theory suggests that crime is reduced when the perceived risk of detection increases [22]. DNA databases significantly enhance the ability of law enforcement to link offenders to crime scenes, thus raising the perceived likelihood of apprehension. This effect is particularly significant in the context of recidivism, the tendency of convicted individuals to reoffend [23]. Empirical evidence shows that individuals whose DNA is stored

in national databases are less likely to commit further crimes [16], highlighting a preventive function that goes beyond solving crimes.

Surveillance Theory, especially Michel Foucault's "panopticism," views biometric databases as instruments of social control [24]. DNA databases are conceptualized as a form of digital surveillance, wherein the continuous potential for observation may alter individual behavior. Critics warn that pervasive biometric monitoring may erode civil liberties and disproportionately target marginalized populations [25]. While this may contribute to crime deterrence, it raises concerns about state overreach, particularly when databases are expanded to include suspects or individuals not convicted of crimes.

Human Rights Theory emphasizes the importance of balancing public interest with individual autonomy [26]. Unlike other identifiers, DNA data contains sensitive genetic information that extends to family members and lineage. Storing such data without consent, especially in cases where individuals are acquitted or not charged, may infringe on the right to privacy and bodily integrity. Under frameworks such as the European Convention on Human Rights (ECHR) and General Data Protection Regulation (GDPR), any intrusion into genetic privacy must meet tests of legality, necessity, and proportionality [27]. This has led to calls for stricter deletion policies and limited retention periods, particularly in jurisdictions like the UK and Japan, where legal challenges have shaped how long DNA profiles may be stored for non-convicted individuals.

Table 1. Demographic and professional information of the sixteen key informants interviewed for the study.

Informant number	Gender	Age (years)	Occupation	DNA-related working experiences
1	Male	55	Judge	23 years in judging civil and criminal cases requiring physical evidence and DNA.
2	Male	50	Forensic physician	10 years of identifying, examining, and collecting physical evidence.
3	Male	48	Forensic physician	22 years of examining physical evidence, investigating the nationality of persons who are not civilly registered.
4	Female	59	Professor in Forensic Genetics	23 years in physical evidence investigation and policy planning of DNA-related agencies, and policy planning of the Forensic Science profession.
5	Male	47	Expert in Forensic Science	5 years in examining physical evidence, DNA from corpses and exhibits at crime scenes, and being an auditor of the Bureau of Quality Standard for Forensic Science agencies in Thailand, ISO17025:2017.
6	Male	66	Policeman	44 years of collecting physical evidence for examination and filing a case.
7	Male	45	Prosecutor	10 years, while being a policeman, in sending physical evidence for examination.
8	Male	54	Expert in strategy and Forensic Science	13 years of writing a DNA pattern matching software program for physical evidence and suspects.
9	Female	38	Expert in Forensic Biology and DNA testing	14 years of investigating physical evidence in cases from inquiry officials, examining the comparison of DNA testing, and preparing reports to supplement court cases.
10	Male	39	Expert in Forensic Biology and DNA testing	10 years of collecting physical evidence at crime scenes, investigating DNA from physical evidence.
11	Male	55	Government officials in the Ministry of Justice	27 years of collecting samples and examining DNA from physical evidence, driving the law on using DNA in the justice system.
12	Male	59	Judge	30 years of judging cases, DNA was used to prove whether someone is a genuine heir and to confirm a wrongdoer.
13	Male	49	Expert in criminology	10 years of working as an officer of the Department of Special Investigation, collecting physical evidence at crime scenes.
14	Male	37	Prosecutor	8 years of bringing scientific witness and evidence to the court's hearing.
15	Male	48	Officer in the Department of Corrections	5 years of working on the policy on keeping the DNA of prisoners who will be released from prison.
16	Male	62	Prosecutor	41 years of working as a policeman and became a prosecutor, and later a university lecturer in law.

2. Materials and Methods

2.1 Documentary research

This study analyzed the literature on DNA biometrics in criminal justice using documentary research and synthesizing ideas, principles, theories, and models from various sources, such as articles, academic journals, books, and websites.

2.2 In-depth interview

This study conducted in-depth interviews with experts in the criminal justice process, including police, prosecutors, courts, correctional officers, forensic doctors, and DNA specialists. The interview questionnaires were developed based on relevant literature reviews, scrutinized by three experts, and consisted of semi-structured and open-ended questions (see Appendix 1).

2.3 Research participants

Sixteen knowledgeable professionals with at least five years of experience in the

criminal justice system, including four police officers, three prosecutors, two judges, two correctional officers, and five forensic experts, participated in this study. Table 1 presents the demographic and professional details of these key informants. Purposive sampling [28, 29] was used to select experts, and the snowball method [30, 31] was used to recruit additional experts. The interviewed experts recommended the other experts, and the interviews were terminated when the researcher reached the saturation point for data collection. If further interviews did not yield additional information [32, 33], participant sampling for in-depth interviews was discontinued, and the data were analyzed.

2.4 Data analysis

Data from documentary research and in-depth interviews were analyzed using a thematic approach and content analysis.

3. Results

3.1 Problems and obstacles in utilizing DNA biometrics

3.1.1 Lack of a centralized authority

Numerous agencies are responsible for examining forensic scientific evidence involving the participants. The Royal Thai Police (RTP) has led the way in physical evidence investigation with other agencies, such as the Central Institute of Forensic Science (CIFS), Department of Special Investigation (DSI), Office of the Narcotics Control Board (ONCB), universities, and government hospitals. Despite the involvement of many agencies in investigating forensic scientific evidence, there is no clear direction or operational goal for collecting and examining DNA from the evidence.

The absence of a central authority for collecting DNA biometric data has resulted in the disparate management of DNA databases. The absence of coordination and information exchange between agencies impedes matching evidence investigation outcomes with database data. Several investigations did not have the expected effectiveness in the case proceedings.

3.1.2 Personnel and budget shortages

The participants also identified personnel and budget issues that caused the delayed investigation timelines. Furthermore, the forensic units face chronic budgetary constraints, particularly concerning the procurement of standardized chemicals essential for DNA extraction. These reagents are costly, and the unpredictable nature of forensic casework makes it difficult to allocate a fixed budget per investigation. When these critical materials are depleted, the analysis of forensic evidence is further delayed, negatively impacting the timeliness

and efficiency of the criminal justice process.

3.1.3 Inadequate professional standards

Professional standards deficiencies for forensic science officers have resulted in complaints of unprofessional behavior. The absence of a central agency responsible for forensic science work management impedes Thailand's forensic science operations and lacks unified supervision and auditing.

3.1.4 Issues with crime scene protection

Issues related to crime scene protection have also emerged. The absence of operational guidelines for collecting evidence relies on the discretion of physicians conducting the identification or autopsy. Insufficient first-response units for rapid rescue may result in evidence being destroyed or moved before the person in charge of the crime scene can access it. Some individuals may inadvertently compromise physical evidence at a crime scene because of a lack of understanding of how to preserve the scene and the evidence. This reason can lead to damage or contamination of scientific evidence.

3.1.5 Judges' limited forensic knowledge

In the Thai legal system, judges are assigned to play a role in considering the weight of evidence for trial and adjudication. However, most Thai judges lack sufficient knowledge to assess the reliability of forensic evidence. Consequently, they often rely on expert witnesses' opinions and are unaware of the limitations of this method.

3.2 Problems and obstacles in the laws

3.2.1 Absence of a law establishing a central DNA authority

No law exists establishing a central agency that administers the National DNA Database. Currently, many agencies are investigating the evidence, physical evidence, and DNA data collection. Each agency has different responsibilities, directions, and operational goals, including standards for storing and examining DNA from physical evidence, resulting in dispersed DNA databases and ongoing disharmony.

3.2.2 Lack of power to compel DNA testing

No law allows courts or inquiry officers to compel defendants to investigate forensic evidence. The Criminal Procedure Code, Section 131/1, permits the examination of scientific evidence from the accused's body but does not empower courts or inquiry officers to do so. As defendants cannot be forced to undergo a DNA test, they may refuse even if doing so would be detrimental to them. The lack of scientific evidence in the trial makes the justice system unfair, as it should be based on witnesses and evidence.

3.2.3 Legal ambiguity regarding prisoner DNA collection

The laws that facilitate mandatory DNA data collection from prisoners are ambiguous. Based on the Corrections Act 2017, Section 36, there is no explicit identification of whether the number 3) "personal identifier" includes DNA data. DNA testing and collection as a database may exceed the power provided by law.

3.3 Appropriate measures

3.3.1 Comparative legal models from other countries

The United Kingdom and the United States have laws granting government officers the power to collect DNA samples from specific individuals for storage in national databases. Intimate samples, such as blood, sperm, urine, pubic hair, and tissues obtained from the body, require written consent from the owner. In contrast, non-intimate samples, such as saliva, buccal swabs, and hair, can be collected without consent. The standard method for collecting DNA samples is to use cotton swabs to wipe the cheek tissue, which causes the least pain to the individual's body [34].

In Asia, Japan represents a successful model, where the national DNA database is overseen by the National Police Agency. The system includes profiles of both convicted criminals and suspects and is integrated with international systems through Interpol protocols. Japan's police DNA database has expanded to include the profiles of over 1.75 million individuals, raising concerns regarding public trust [35]. Japan's database has played a key role in solving major crimes and cases of missing persons, especially following the Tsunami disaster of 2011. Participants reported that the RTP and CIFS were the leading agencies responsible for managing most of Thailand's DNA databases. The RTP manages the DNA database for individuals accused of crimes, whereas the CIFS manages the database for convicted prisoners. As a result, Thailand's DNA database is fragmented, as each organization focuses on collecting DNA data from offenders to fulfill its specific mission. In contrast, the United Kingdom, the United States, and Japan have authorized a single agency to oversee and manage their national DNA

Table 2. Comparative models of national DNA biometric systems: UK, US, Japan, and Thailand.

	United Kingdom [36]	United States [14]	Japan [35]	Thailand
Year of Establishment	1995	1998	2005	No official nationwide launch
Governance and Management	Managed by the Home Office, the National DNA Database (NDNAD) is highly centralized and closely integrated with law enforcement across England, Wales, and Northern Ireland.	Governed by the Federal Bureau of Investigation (FBI) through the CODIS. It operates on a tiered structure—local (LDIS), state (SDIS), and national (NDIS)—allowing decentralized input but centralized oversight.	Administered by the National Police Agency (NPA). It uses a centralized system, but DNA collection and profiling are performed at prefectural forensic science laboratories.	Managed by multiple agencies, e.g., RTP, CIFS, universities, and hospitals.
Legal Framework and Privacy	Governed by the Protection of Freedoms Act 2012, which mandates the deletion of DNA profiles if individuals are acquitted or not charged. Strict legal oversight is applied to retention and access.	Legal protections vary by state. The DNA Fingerprint Act of 2005 allows the inclusion of arrestees and convicted individuals. Expungement requires an active petition.	Operates under internal NPA regulations.	Criminal Procedure Code Sec. 131/1; Corrections Act 2017; Official Information Act of 1997; no centralized DNA legislation.
Scope of Data and Use	Stores over 7 million profiles, including crime scene samples. Supports both criminal investigations and victim identification. Significant use in solving historic crimes.	Contains over 21 million profiles. Includes convicted offenders, arrestees, and forensic samples. Used extensively for cold case resolution, inter-state matching, and federal crime investigations.	Holds about 1.3 million profiles, primarily from convicted offenders and forensic evidence. Strong emphasis on crimes and disaster victim identification (e.g., 2011 tsunami).	Fragmented profiles across multiple agencies.
International Integration	Shares data with other EU nations through the Prüm Convention and collaborates with Interpol.	CODIS is deployed in over 50 countries and integrated with the Interpol DNA Gateway. Offers international training and software support.	Cooperates with Interpol. It uses a proprietary system aligned with global standards.	Recently adopted CODIS; Interpol cooperation in development.
Retention and Deletion Policies	DNA profiles from uncharged or acquitted individuals must be deleted (typically within 3 years), except in national security cases.	Retains DNA profiles indefinitely unless expungement is formally requested and granted. No automatic deletion for acquitted individuals.	DNA retention is case-based and follows NPA's regulation, but has a lack of legal safeguards regarding the collection, storage, and deletion of personal data, which can lead to the lifelong treatment of innocent people as criminal suspects, and violations of individual rights and privacy.	No uniform policy; varies by agency; retention laws are undefined.
Effectiveness	Generated more than 800,000 matches to unsolved crimes overall, with an average of 35,000 annually.	Over 700,000 crime investigations aided by CODIS; strong deterrent effect and fast cold case resolution	Solved over 100,000 cases; especially strong in serial crime detection and DVI.	Used in major cases; lacks central database, limits full impact.

databases. A comparative analysis of legal frameworks between Thailand and selected developed countries is presented in Table 2.

3.3.2 Data privacy and protection

Protecting personal data in a DNA database is crucial to establishing appropriate measures to prevent unauthorized disclosures or exploitation. State agencies should secure personal data to benefit the criminal justice system. In the United Kingdom, the number of people with access to such data is limited, and the Protection of Freedoms Act 2012 outlines the specific purposes for which DNA data can be used, including national security, terrorism investigations, crime prevention and suppression, and prosecution. In the United States, the FBI is authorized to store data in the national DNA database, and access requires an encryption key. CODIS software is only accessible to specified individuals, and DNA data are separated from the owner's data to prevent the misuse of infor-

mation on genetic characteristics. The use of individual DNA data is restricted to cases in the criminal justice system.

Currently, there are no specific laws regulating the disclosure of DNA data in Thailand. Recently, the government followed the Official Information Act of 1997, which allows for disclosing DNA data to state officers to prevent law violations or non-compliance, conduct investigations and inquiries, or institute legal actions. However, DNA data are unique in that they can reveal not only a person's genetic characteristics but also their relationships with close relatives. As a result, some argue that the Official Information Act of 1997 was insufficient to protect the individual DNA data held by state agencies. Therefore, there is a need for a specific law that outlines the scope of DNA data disclosure and usage. We propose it should be limited to situations involving national security, inquiries, investigations, and should benefit the criminal justice system.

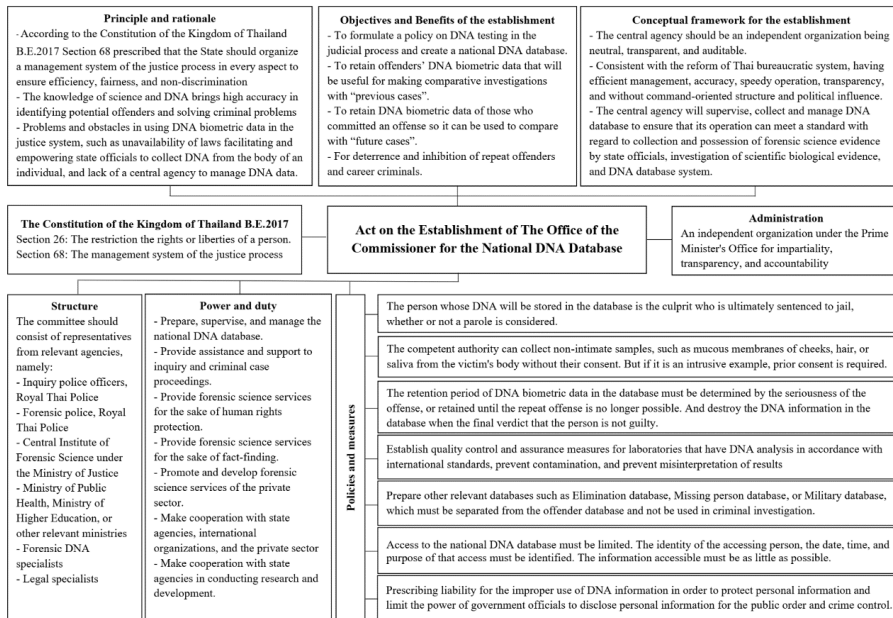


Fig. 1. A DNA biometric implementation model to promote Thailand's criminal justice system.

3.3.3 DNA retention and destruction policies

DNA data are more sensitive than general individual data; therefore, states implement database deletion policies when the time comes. Every country follows its own rules. DNA samples and profiles are stored for future testing in the US without a specific duration. However, individuals must request the destruction of their samples and profiles by submitting a court judgment of dismissal, not a guilty verdict, or absence of any legal action within the prescribed timeframe. The UK considers the age, severity, and recurrence of wrongdoing to determine the scope and duration of storing DNA data in a national database.

Many participants have recommended that Thailand establish principles for empowering an agency to store DNA data, taking into account various factors, such as the severity of the crime, age, individual involvement, and recurrence. Therefore, it is crucial to consider both

juvenile and first-time offenses carefully. Additionally, the DNA data of individuals collected during criminal investigations must be destroyed if they are not charged or the court finds them not guilty.

3.3.4 Draft proposal for a Thai DNA database act

The authors collected information from the participants and proposed a draft for the Act on the Establishment of the Office of the Commissioner for the National DNA Database to improve and solve problems and obstacles related to forensic science in Thailand. This law compiles laws related to DNA analysis and data management and provides guidelines for collection and analysis while ensuring the rights and freedom of individuals. The criteria for individual DNA data's disclosure, storage, and destruction must be determined. Fig. 1 illustrates the conceptual framework, structure, power, duty, and liability of law.

4. Discussion

Policy and management problems arise from the lack of efficiency and unity in the forensic science work management system in specifying explicit and necessary measures, rules, regulations, standards, policies, and goals to ensure operations are conducted in the same manner. Thailand has many agencies that are responsible for investigating forensic scientific evidence. Each agency has management and operational policies that do not completely align with each other, causing evidence to not be accepted by the litigant. This inconsistency is in agreement with a previous study describing the problems and obstacles in forensic science in Thailand caused by improper and unclear management [37]. Meanwhile, the operations of related agencies were not integrated or oriented in the same direction.

The absence of a central agency in charge of collecting DNA data and managing DNA databases makes it impossible to match the evidence found at a crime scene with the database, making arrest and prosecution more difficult. This lack of DNA database management is consistent with a study that showed that an insufficient DNA database in the justice system leads to an inability to fully process physical evidence at a crime scene [38].

A shortage of personnel with expertise in forensic investigations gives rise to inappropriate work, causing crime scene analysis and evidence collection not to be performed in a standard manner with proper quality control. Such problems align with the Thai legal system development project reports that explained six significant problems: 1) Police and inquiry officers give more importance to witnesses and confession than employing DNA to help identify a wrongdoer, 2) The data used to con-

duct a comparative investigation of DNA collected from a crime scene are incomplete because of the shortage of a supportive budget, and a strict security system for the database is not available, 3) The police officer who was the first to arrive at the crime scene did not strictly protect it, 4) Experts or investigation officers did not collect or pack the crime-scene physical evidence, 5) Many agencies have a shortage of experts, tools, chemicals, and DNA testing laboratories, 6) DNA is only used in some cases because of its high cost [39]. These problems relate to expert witnesses' credibility, reliability, qualifications, and neutrality.

Most judges do not have experience or confidence in analyzing the reliability of forensic scientific evidence because they do not have the necessary scientific knowledge. This problem is consistent with a study on problems related to forensic scientific evidence during court trials. They also stated that judges do not have sufficient forensic science knowledge and physical evidence for investigation, which affects judicial discretion and judgment [37].

No law empowers courts or inquiry officers to force the examination of forensic science evidence with those investigated; punishment is provided when that person disagrees or does not cooperate with the examination. As the examination of defendants' physical evidence is not mandatory, the defendants can refuse to consent to a DNA test, causing the file of preliminary examination at the court level to not have the necessary scientific evidence during the trial in court, making the justice system unfair. This finding is consistent with a study examining scientific evidence in criminal cases under the Criminal Procedure Code. The law does not empower courts or inquiry officers to examine scientific evidence of alleged offenders [40].

Most countries, including Thailand, have a consistent conceptual framework for protecting the right to one's own body. The state certifies and protects its people, but its protection is not without limits. It must be considered that partially restricting the rights over one's own body for a specific reason might enable the state to achieve a mission, especially important if that mission is related to national security. However, when the state has the legitimate power to take any action that may affect the right to one's own body, the state shall specify conditions as an operating framework for state officers, such as specifying an offense in which state officers have the authority to collect DNA evidence from an individual's body. This authority should protect an individual's rights, the state's existence, the public interest, and the people's order [41]. This principle aligns with Human Rights Theory, which emphasizes that any interference with bodily autonomy must be justified by law, proportionate, and necessary.

DNA collection should ideally serve the public's interest in maintaining peace, order, and security. Consequently, people must agree to restrict the rights of some individuals, such as prisoners, alleged offenders, and criminal case defendants, to achieve the state's objectives of controlling, preventing, and suppressing crimes. Since the availability of DNA data from offenders and comparative investigation of crime-scene DNA is established efficiently, it can provide a prompt and particular court trial for suitable offenders. This objective is consistent with the Deterrence Theory [23]. Consequently, enhancing the efficiency of forensic science evidence investigation by establishing a national DNA database will help suppress criminals from recidivism.

From the perspective of Surveillance

Theory, the current fragmentation and lack of clear oversight in Thailand's DNA biometric system raise critical concerns about state surveillance. Although Thailand has not established a centralized national DNA database, multiple agencies collect and manage DNA data independently, with minimal legal restrictions or standardized protocols. This decentralized approach increases the risk of under-surveillance and misuse, especially when no unified retention, access, or deletion policies exist. Surveillance Theory cautions that even the potential for being observed, through the storage of biological identifiers, can influence individual behavior and reinforce state control [42].

Table 2 provides a comparative overview of DNA biometric database models in the United Kingdom, the United States, Japan, and Thailand. The analysis reveals stark contrasts between Thailand and the selected developed countries regarding governance, legal frameworks, international cooperation, and policy standardization. While the UK, US, and Japan have centralized systems managed by legally empowered agencies with explicit privacy and retention protocols, Thailand's system remains fragmented and loosely regulated. Moreover, developed countries demonstrate integration with international databases such as Interpol and CODIS, facilitating global cooperation, whereas Thailand has only recently begun adopting CODIS and remains in the early stages of international alignment. These disparities underscore the urgent need for Thailand to establish a centralized legal and operational framework to unify its agencies, enforce data protection, and define retention and deletion policies.

INTERPOL's Best Practice Principles for the Establishment of a National

DNA Database emphasize several foundational pillars: a strong legal framework, standardized operating procedures, international interoperability, data protection, and quality assurance through ISO/IEC 17025 accreditation [43]. The results of this study confirm that Thailand currently falls short of these benchmarks. Furthermore, the INTERPOL Global DNA Profiling Survey 2019 reveals that out of 194 member countries, 70 reported having national DNA databases, and 31 had specialized missing persons DNA databases [44]. Thailand, notably, is absent from both lists, reflecting its lack of a consolidated national system. This absence further confirms the study's findings. Therefore, the study strongly supports the urgent adoption of INTERPOL's recommendations to establish a centralized, legally regulated, and internationally aligned DNA database to improve justice outcomes and global collaboration.

5. Conclusion

The national DNA database helps solve crimes by comparing DNA evidence found at crime scenes with the DNA of suspects. This database helps prevent repeat offenses by individuals whose DNA is stored there. There are internationally recognized methods for acquiring DNA data according to legislation, which include criteria, problems, and obstacles. Thailand uses DNA biometrics in its justice system on a case-by-case basis; however, some laws challenge the creation of a national DNA database. These challenges include acquiring DNA evidence, obtaining consent, state officers' authority, managing information, and disclosing information. In addition, different agencies in Thailand are responsible for managing DNA data, which leads to wasteful spending and makes it difficult to control access. DNA data are of-

ten distributed to various agencies, which increases the chances of state officers misusing or disclosing the data. Destruction of DNA data varies according to the objectives of each agency, which may result in a lack of data in the central genetic database for future crime suppression.

To address the issues mentioned above, it is necessary to establish a central agency to manage DNA data storage and ensure unity and efficiency. This agency should be responsible for protecting DNA data with a higher standard than personal data. Legislation should also be provided to specifically address the disclosure or utilization of DNA data for various benefits and to outline state officers' liabilities if DNA data are disclosed beyond the scope specified by law.

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Appendix

Interview questionnaires

This research is qualitative research aims to study the problems and obstacles to the use of biometric DNA in Thai justice processes, the problems and obstacles in Thai law in the use of biometric DNA data in the justice process, foreign models of DNA biometrics use, and appropriate measures for the use of biometric DNA in the Thai justice system.

As a competent person, you are selected to participate in this research. Therefore, we ask for your cooperation in responding to this interview based on your knowledge and opinions in academics without any prejudice to use this information to further process and present it in the form of research work.

Personal data

- Field of expertise
- Age
- Sex
- Occupation
- Position
- Work experience (e.g., position, number of years)

Interview questionnaires

1. Have you ever worked with DNA testing for use in criminal justice? In what role?
2. Have you ever had any obstacles in your work that are related to DNA testing? Please explain.
3. DNA data can be numerical and used for personal identification. We might call it DNA Biometrics. Do you think Thailand should have a DNA Biometric testing system for criminal offenders? Why?
4. To prepare the biometric systems, the state has to establish the databases. Should a national DNA database be established to compare the DNA found at the scene? Why?
5. Several departments, such as the forensic police under the Royal Thai Police, the Central Institute of Forensic Science under the Ministry of Justice, the forensic doctor under the universities, and the forensic doctors under the Ministry of Public Health, have done DNA testing in the Thai justice process, which agency should be the principal administrator of the national DNA Database? Why?
6. Does storing the offender's DNA in a national database to be used in a criminal investigation deprive the offender's rights? Why? (Or would you feel deprived if your DNA biometric data were kept in the database?)
7. There are different types of serious and non-serious criminals and habitual offenses; what types of criminal

- offenders should DNA be stored in the national database?
8. In some countries, offenders' DNA is stored without consent (force storage). For Thailand, should storing the DNA biometrics of the offenders in the national DNA database require the consent of the offenders? Why?
 9. Some countries store the offender's DNA biometric data for the rest of their lives, or some countries store it for 20 years and then destroy it. How long should those offenders' DNA data be kept in Thailand's national database?
 10. Who should be the authority to access and use this national DNA database?
 11. What level of confidentiality should the information in this national DNA database be? What are the penalties for fraudulent use? If there is a leak negligently or not intended, should there be penalties? How severe?
 12. Do you have any further thoughts on DNA biometric applications in the criminal justice process?