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FORENSIC FINGERPRINTING: SCIENTIFIC ACCURACY AND LEGAL ADMISSIBILITY IN CRIMINAL TRIALS

Sornalakshmi V S[1]

I. ABSTRACT

Fingerprint evidence has developed as one of the most important forms of scientific evidence used in criminal investigations and court processes. Fingerprint identification's reliability is mainly based on the principles of individuality and permanence. These principles have helped courts and investigating agencies to use fingerprint analysis as an effective mechanism for establishing identity and connecting accused people to crime scenes. Recent years have seen the evolution of forensic science and digital technologies such as Automated Fingerprint Identification Systems (AFIS), biometric databases and digital imaging techniques which have greatly enhanced the efficiency and accuracy of fingerprint analysis. Fingerprint evidence, regardless of its probative value, continues to present substantial legal and constitutional problems. Poor collection procedures, bias on the part of examiners, partial prints, contamination and technical deficiencies can compromise the reliability of forensic findings and lead to wrongful convictions. Moreover, the increasing proliferation of biometric surveillance and centralised data collection systems has led to heated debates as to privacy rights, data protection and state surveillance especially following the constitutional recognition of privacy as a fundamental right in Justice K.S. Puttaswamy v. Union of India. This research critically reviews the scientific basis of fingerprint identification, the legal regime for fingerprint evidence in India and some landmark judicial pronouncements on the admissibility and constitutional limitations of fingerprint evidence. The report also looks at the implications of the Criminal Procedure (Identification) Act, 2022 and the Digital Personal Data Protection Act, 2023 on the collection, storage and preservation of biometric evidence. It ends with recommendations for reforms to improve forensic accountability, procedural safeguards, scientific standardisation and privacy protection within India's criminal justice system.

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II. KEYWORDS

Fingerprint Evidence; Forensic Science; Criminal Investigation; Biometric Identification; Evidentiary Value.

III. INTRODUCTION

The administration of criminal justice is largely dependent on precise identification of offenders and reliability of evidentiary procedures adopted during criminal investigations. Among the various types of scientific evidence used in criminal trials, fingerprint evidence has attained considerable significance because of its scientific reliability, permanence and uniqueness. Fingerprint identification is one of the most reliable means of personal identification in forensic science and has become an integral part of modern criminal investigations and judicial proceedings.[2]

Criminal investigations traditionally relied on anthropometric measurements, photographs, eyewitness accounts, and physical descriptions to identify offenders. Yet these methods often lacked scientific exactness and were susceptible to error and manipulation and were subject to mistaken identity. Fingerprint science was developed in the nineteenth century. It gave a systematic and relatively reliable means of identification using friction ridge analysis. Pioneers in this field were Sir Francis Galton, Sir Edward Henry, Henry Faulds and Sir William Herschel, who helped make the fingerprint examination a recognised science.[3]

The creation of the Henry Classification System in colonial India also helped to institutionalise the use of fingerprints in criminal investigation systems around the world.

Fingerprint evidence is a major factor in the criminal justice system in India. Fingerprint examination is a regular instrument used by the investigating agencies to establish the presence of an accused person at the scene of crime, to corroborate circumstantial evidence, to identify habitual offenders and to strengthen prosecutorial

[2] FRANCIS GALTON, FINGERPRINTS 1–12 (Macmillan & Co. 1892).
[3] SIR EDWARD R. HENRY, CLASSIFICATION AND USES OF FINGERPRINTS 15–28 (H.M. Stationery Office 1900).

claims. The Bharatiya Sakshya Adhiniyam, 2023 recognises the opinion of an expert in fingerprints as having evidentiary importance and the Criminal Procedure (Identification) Act, 2022 provides for collection and retention of biometric data including fingerprints for investigative purposes.[4] Indian courts have consistently held that fingerprint identification is of evidentiary value subject to procedural safeguards and proper forensic examination.

The progress in technology has widened the horizon and the utility of fingerprint science. The advent of Automated Fingerprint Identification Systems (AFIS), biometric databases, digital imaging technologies and electronic surveillance systems have resulted in a substantial boost in the speed and efficiency of criminal investigations. Such technological advances have made it possible to process and compare fingerprints on a large scale more accurately and conveniently by investigating agencies. These developments notwithstanding, the growing dependence on biometrics has prompted serious legal and constitutional concerns. Questions concerning privacy rights, data protection, biometric surveillance, procedural fairness and the reliability of forensic methodologies have grown in importance in the contemporary administration of criminal justice.

The evidentiary reliability of fingerprint examination continues to be challenged by concerns over examiner bias, contaminated crime scenes, partial prints, technological limitations, and the possibility of wrongful identification. The Supreme Court's recognition of the right to privacy as a fundamental right in *Justice K.S. Puttaswamy v. Union of India* has only heightened the debate on the constitutional constraints on the collection, storage and use of biometric data by the State.[5]

Thus, this paper aims to critically analyse the scientific basis, reliability of evidence, legal admissibility, and constitutional issues of the fingerprint evidence in the Indian criminal justice system. The paper also elaborates on the important judicial pronouncements, statutory developments, and emerging challenges concerning biometric technologies and forensic accountability in criminal trials.

[4] The Bharatiya Sakshya Adhiniyam, No. 47 of 2023, § 39 (India).
[5] Justice K.S. Puttaswamy v. Union of India, (2017) 10 S.C.C. 1 (India).

A. Research Problem

Fingerprints have long been used as a legitimate scientific method of identification, but in the criminal justice system there are serious issues concerning the reliability of the evidence, procedural safeguards, and constitutional implications. While fingerprint analysis is a well-established and highly accurate technique, the reliability of forensic results can be compromised by the examiner's bias, contamination at the crime scene, partial or poor-quality prints, and technological limitations that can lead to incorrect identifications.

The rising use of biometric technology and the establishment of central fingerprint databases have also raised serious legal and constitutional issues related to privacy rights, data protection and state surveillance. The scope of investigation of the law enforcement agencies has been expanded by the Criminal Procedure (Identification) Act, 2022 and has led to debates on the permissible ambit of collection, storage and retention of biometric data. The Supreme Court in K.S. In Puttaswamy v. Union of India, the right to privacy was recognised as a fundamental right and the need to balance the need of effective criminal investigation with the need to protect constitutional rights and personal liberties was stressed on. The evidentiary value of fingerprint evidence in criminal proceedings is still undermined by the lack of uniform procedures for forensic analysis, independent oversight bodies and effective regulatory safeguards for fingerprint analysis.

Problems such as shoddy collection practices, lack of standardization in forensic laboratories, inadequate verification procedures and an over-reliance on expert testimony have compounded the problems of wrongful convictions due to forensic errors. The growing use of digital biometric systems and Automated Fingerprint Identification Systems (AFIS) has also raised concerns about cyber security risks, unauthorised access to biometric databases and long-term retention of personal data by investigating agencies. Such technologies undoubtedly improve the efficiency of investigations, but they also raise important questions of proportionality, accountability and protection against arbitrary surveillance.

Hence, the central question addressed in this study is the extent to which fingerprint evidence can be viewed as scientifically reliable and legally admissible in the Indian criminal justice system while simultaneously safeguarding procedural fairness, constitutional protection, forensic accountability and protection of individual privacy rights.

B. Research Objectives

1. To learn how fingerprints are used in investigations and help solve crimes.
2. To examine the use of fingerprint evidence and expert evidence in Indian courts.
3. To see if collecting data such as fingerprints is against the rules of privacy and self-incrimination in our Constitution.
4. To study how new technologies, such as Automated Fingerprint Identification Systems are changing the way crimes are investigated and forensic work is done.
5. To find out the problems with fingerprint examination, such, as examiners, contamination and technical mistakes.
6. To study the impact of legislations such as Criminal Procedure (Identification) Act and Digital Personal Data Protection Act on collection and retention of biometric evidence.
7. To suggest changes that can be made to the forensic processes to make them more reliable, protect privacy and ensure accountability in the justice system, we need to focus on the fingerprint evidence and its collection.

C. Research Questions

1. What scientific principles establish the reliability and uniqueness of fingerprint identification in criminal investigations?
2. How is fingerprint evidence governed and admitted under the Indian legal framework and judicial system?
3. What constitutional and privacy concerns arise from the collection, storage, and use of biometric fingerprint data?

4. What reforms are needed to improve forensic accountability, procedural protections and the reliability of fingerprint evidence presented at criminal trials?

D. Research Hypotheses

1. The improper collection, preservation, and examination of fingerprint evidence may lead to forensic inaccuracies and wrongful identification during criminal investigations and judicial proceedings.
2. The increasing use of biometric fingerprint databases and digital surveillance technologies may result in greater concerns relating to privacy violations, unauthorized data retention, and excessive state surveillance.

E. Research Methodology

The present study uses a doctrinal research methodology based on analytical and descriptive analysis of legal principles, statutory provisions, judicial decisions and forensic literature concerning fingerprint evidence and criminal investigations. The study is mainly concerned with a qualitative analysis of legal and forensic materials in terms of the scientific reliability and admissibility of fingerprint evidence in the Indian criminal justice system.

The study has relied upon primary sources such as the Bharatiya Sakshya Adhiniyam, 2023, the Criminal Procedure (Identification) Act, 2022, the Constitution of India, the Digital Personal Data Protection Act, 2023 and relevant judicial pronouncements of the Supreme Court and various High Courts of India. Also, important case laws on expert evidence, forensic examination, privacy rights and biometric identification have been examined to understand the judicial approach to fingerprint evidence.

Secondary sources for the research include books, journal articles, research papers, forensic science reports, government publications, legal commentaries and academic writings on fingerprint science, forensic administration, constitutional law and criminal justice. Further, the scientific reliability and practical limitations of fingerprint examination have been evaluated with reference to relevant scholarly opinions and forensic studies. The study is limited to scientific accuracy, legal

admissibility, constitutional implications and evidentiary value of fingerprint evidence in criminal trials in the Indian legal framework. The research also examines the contemporary issues of the biometric technologies, the forensic accountability, the procedural safeguards and the privacy protection in the contemporary criminal investigations.

F. Literature Review

1. Francis Galton, Finger Prints (1892)

Francis Galton in his seminal work Fingerprints published in 1892 laid the scientific foundation for fingerprint identification by establishing the principles of individuality and permanence of fingerprint. Through his scientific observation and statistical analysis Galton proved that no two people have the same fingerprint ridge patterns and that these patterns do not change throughout a person's life. The work also classified fingerprints into loops, whorls and arches, thus making an important contribution to the development of modern forensic fingerprint science.[6]

2. Sir Edward R. Henry, Classification and Uses of Finger Prints (1900)

In 1900 Sir Edward Henry, in his work Classification and Uses of Finger Prints, developed the Henry Classification System to systematically record and identify fingerprints. The study showed how fingerprint classification is used in practice in criminal investigation and policing administration. Henry's classification system was first implemented in the colonial India and later internationally, becoming one of the most influential systems of criminal identification in the history of forensics.[7]

3. Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification 2005

In his research article More Than Zero: Accounting for Error in Latent Fingerprint Identification, Simon A. Cole critically examined the possibility of human error and wrongful identification in fingerprint examination. The study challenged the

[6] FRANCIS GALTON, FINGER PRINTS 1–45 (Macmillan & Co. 1892)
[7] SIR EDWARD R. HENRY, CLASSIFICATION AND USES OF FINGER PRINTS 15–28 (H.M. Stationery Office 1900)

assumption that the fingerprint analysis is 100% fail-safe and emphasised the need for scientific accountability, verification procedures and quality control procedures in forensic laboratories. The article highlighted problems with examiner bias, subjective interpretation and the lack of universal numerical standards for fingerprint matching.[8]

4. **Jennifer L. Mnookin, The Validity of Latent Fingerprint Identification: Confessions of a Fingerprinting Moderate, 2008**

Jennifer L. Mnookin in her article The Validity of Latent Fingerprint Identification: Confessions of a Fingerprinting Moderate, analysed the evidentiary validity and scientific reliability of latent fingerprint examination. The author outlined the strengths of fingerprint identification and at the same time addressed concerns about methodological limitations, examiner subjectivity, and procedural inconsistencies. The article, in particular, highlighted the importance of robust judicial review and scientific openness in the presentation of fingerprint evidence in criminal proceedings.[9]

5. **Strengthening Forensic Science in the United States: A Path Forward (2009)**

The 2009 report, Strengthening Forensic Science in the United States: A Path Forward, by the National Research Council, provided a critical review of the science base and institutional practices surrounding the forensic sciences, including fingerprint analysis. The report highlighted significant shortfalls in forensic standardization, laboratory accreditation and examiner training and verification practices.[10]

[8] Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification, 95 J. CRIM. L. & CRIMINOLOGY 985, 987–1008 (2005)
[9] Jennifer L. Mnookin, The Validity of Latent Fingerprint Identification: Confessions of a Fingerprinting Moderate, 7 LAW, PROBABILITY & RISK 127, 127–41 (2008)
[10] NAT'L RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 136–45 (2009)

IV. RESEARCH & ANALYSIS

A. Historical Development of Fingerprint Science

Fingerprint identification is one of the oldest and most reliable types of personal identification in the history of forensic science. The scientific use of fingerprints for crime investigations was recognised in the nineteenth century, but ancient records show that ancient civilisations acknowledged the uniqueness of finger impressions and used them for identification and authentication purposes. Archaeological findings from ancient Babylon, Persia and China suggest that fingerprints and thumb impressions were widely used on clay tablets, contracts, seals and commercial documents to prove identity and authenticity.[11]

In ancient China, during the Qin and Han dynasties, fingerprints and thumb impressions were often affixed to legal documents and business agreements. Likewise, Babylonian merchants used fingerprints on clay tablets for commercial transactions to determine identity and authenticity. But these were not scientifically analysed, nor systematically used for the identification of criminals. At that time, fingerprints were considered merely identifying marks, not scientifically reliable evidence.[12]

Fingerprint analysis was developed as a scientific discipline in the 1800s. One of the first scientific studies of fingerprint ridge patterns was done by the Czech anatomist Jan Evangelista Purkyně in 1823. He classified fingerprints into various classes based on ridge formations and made a great contribution for the development of dermatoglyphics. His work was mainly anatomical and not forensic, but it laid the foundation for future scientific research into fingerprint identification.[13] The next big step was made by Sir William Herschel, a British official working in colonial India.

[11] SIR EDWARD R. HENRY, CLASSIFICATION AND USES OF FINGER PRINTS 15–20 (H.M. Stationery Office 1900).
[12] K.S. NARAYAN REDDY & O.P. MURTY, THE ESSENTIALS OF FORENSIC MEDICINE AND TOXICOLOGY 57–60 (34th ed. 2017).
[13] Jan Evangelista Purkyně, Commentatio de Examine Physiologico Organi Visus et Systematis Cutanei (1823).

In 1858, Herschel started using fingerprints on contracts and official documents in Bengal to stop impersonation and fraudulent transactions. By watching over a long period of time, he decided that the patterns of fingerprints never changed during a person's whole life. Fingerprint use in administration showed that they were practical and was a major reason for their adoption by governments and legal systems.[14]

Another important contributor was Henry Faulds, a Scottish physician working in Japan. In 1880, Faulds wrote an article in the journal Nature on the forensic potential of fingerprints in criminal investigations. He proposed the use of latent fingerprints at a crime scene to identify the criminal. He advocated systematic collection and comparison of fingerprint impressions.

His research aroused much scientific interest and stimulated further progress in the science of fingerprints.[15] Sir Francis Galton did something important for fingerprint identification. He wrote an important book called 'Finger Prints that came out in 1892. In this book Galton showed that every person has fingerprints that're unique and do not change. He said that fingerprints can be classified as loops, whorls and arches. Sir Francis Galton created a system, for fingerprint identification. This system is based on science. Sir Francis Galton's pioneering research significantly transformed the scientific understanding of personal identification and established fingerprints as a reliable method of forensic identification.

Through systematic classification and empirical analysis, Galton demonstrated the uniqueness and permanence of fingerprint patterns, thereby laying the foundation for the scientific acceptance of fingerprint evidence in criminal investigations. His contributions continue to influence modern forensic science and contemporary identification techniques.[16]

Fingerprint science plays a crucial role in the administration of criminal justice by assisting investigative agencies in the identification of offenders, verification of criminal records, and establishment of evidentiary links between suspects and crime

[14] William Herschel, Skin Furrows of the Hand, 23 NATURE 76, 76–77 (1880).
[15] Henry Faulds, On the Skin-Furrows of the Hand, 22 NATURE 605, 605–07 (1880).
[16] FRANCIS GALTON, FINGER PRINTS 1–45 (Macmillan & Co. 1892).

scenes. Sir Edward Henry worked with two police officers, Azizul Haque and Hem Chandra Bose to make fingerprinting a big part of this. They created the Henry Classification System together.

This system made it easy to record classify and find fingerprint records in a way. The Henry Classification System was first used in India in 1897. On it was used all around the world. The first Fingerprint Bureau was set up in Calcutta. This was a milestone for forensic administration. It also showed that fingerprint identification is better than the methods developed by Alphonse Bertillon, which were based on measuring the body. Fingerprint science and the use of fingerprint records are very important, for administration and the work of Sir Edward Henry and his team is still remembered today.[17] In the century fingerprint evidence became a very important part of solving crimes and figuring out what happened. Courts started to believe that looking at fingerprints was a way to get to the truth as long as experts were explaining what they found and people were following the right steps to collect and examine the fingerprints. Fingerprint evidence was used around the world to help with criminal investigation and forensic science.

The courts accepted fingerprint examination because it was seen as scientific evidence when experts were testifying and the right forensic procedures were being followed with fingerprint evidence. Fingerprint identification has been changed in the last few decades by new technology such as digital imaging, biometric databases, and automated fingerprint identification systems (AFIS) that allow for rapid comparison and analysis of fingerprints on a large scale.[18] Despite these technological advances, contemporary fingerprint science still raises significant legal and ethical questions of privacy, biometric surveillance, data protection and forensic accountability. Thus, the historical development of fingerprint science has been a reflection not only of scientific and technological advancement, but of the continuing need for procedural safeguards and constitutional protection in the administration of criminal justice.

[17] SIR EDWARD R. HENRY, CLASSIFICATION AND USES OF FINGER PRINTS 45–60 (H.M. Stationery Office 1900).
[18] DAVID A. STONEY, Fingerprint Identification: Scientific Status, in MODERN SCIENTIFIC EVIDENCE 1–32 (David L. Faigman et al. eds., 2002).

B. Types And Classification of Fingerprints

The science of fingerprint identification is based on the analysis of friction ridge patterns on the fingers, palms and soles of humans. These ridge patterns are moulded during foetal development and are permanent to a person's lifetime unless serious injury or damage to the skin occurs. The uniqueness and permanence of these ridge formations make fingerprints one of the most infallible means of personal identification in criminal investigation and forensic science.[19] Fingerprint examination is largely concerned with the identification and comparison of ridge characteristics called minutia points. Minutiae are ridge endings, bifurcations, dots, islands, enclosures, and short ridges. These features will be studied by forensic experts looking at the arrangement, sequence and position to determine whether two fingerprint impressions were made by the same person. The scientific basis for fingerprint comparison and identification is that minutiae patterns are unique.[20] Fingerprints are generally divided into three major types, called loops, whorls and arches. The system of classification allows for the orderly identification, comparison and storage of fingerprint records in forensic and law enforcement databases.

1. Loop Fingerprints

Loop fingerprints are the most common type of fingerprint pattern. The ridges in the loop patterns come in from one side of the finger, recurve, and come out on the same side. Loops typically contain one delta and one core. Loop fingerprints are further divided into ulnar loops and radial loops based on the direction of the ridge flow. Ulnar loops flow toward the little finger and radial loops flow toward the thumb.[21]

2. Whorls Fingerprints

Whorl fingerprints feature circular, spiral, or concentric ridge formations. The patterns usually have two deltas. The ridge arrangements are fairly complex. Plain whorls, central pocket loop whorls, double loop whorls and accidental whorls are the

[19] FRANCIS GALTON, FINGER PRINTS 1–20 (Macmillan & Co. 1892).
[20] Jennifer L. Mnookin, The Validity of Latent Fingerprint Identification: Confessions of a Fingerprinting Moderate, 7 LAW, PROBABILITY & RISK 127, 127–41 (2008).
[21] K.S. NARAYAN REDDY & O.P. MURTY, THE ESSENTIALS OF FORENSIC MEDICINE AND TOXICOLOGY 61–63 (34th ed. 2017).

classifications for whorls. Whorl fingerprints are highly valuable evidence in forensic investigation because of their complex and unique ridge patterns.[22]

3. Arch Prints

Arch fingerprints are the most basic and rarest of all fingerprint patterns. Arch patterns have ridges that go in one side of the finger and out the other without turning back. Primarily, there are two types of arches, the plain arch and the tented arch. Plain arches have smooth, wave-like ridges, whereas tented arches have a sharp upward thrust at the centre of the ridge pattern.[23] In addition to pattern classification, fingerprints are categorised based on their manner of deposition in crime scenes. These categories are latent fingerprints, plastic fingerprints and patent fingerprints.

Patent Fingerprints These are visible marks left by substances such as blood, ink, grease or dirt. These prints can be examined directly, without the need for additional forensic processing. Plastic fingerprints are three-dimensional impressions made in soft materials such as wax, clay, soap or wet paint. These prints retain the ridge detail in a raised or indented form and are often photographed and cast for forensic examination.[24]

Latent prints are the most significant type of evidence in a criminal investigation. These prints are normally invisible to the naked eye, they are made up of natural oils, sweat and secretions on the skin. Latent prints must be visualised and collected using special forensic techniques such as powder dusting, chemical processing, alternate light sources and cyanoacrylate fuming. Latent fingerprints are frequently recovered from crime scenes and are therefore of great evidentiary value in criminal adjudication.[25]

Much of the development of forensic science and of criminal investigation procedures is due to the classification and systematic study of fingerprints. The fingerprint

[22] SIR EDWARD R. HENRY, CLASSIFICATION AND USES OF FINGER PRINTS 32–45 (H.M. Stationery Office 1900).
[23] FRANCIS GALTON, FINGER PRINTS 66–75 (Macmillan & Co. 1892).
[24] Andre A. Moenssens, Fingerprint Techniques and the Theory of Identification, 39 VILL. L. REV. 1073, 1075–1102 (1994).
[25] NAT'L RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 136–45 (2009).

comparison and identification have been improved in terms of speed, efficiency, and accuracy by modern technologies such as Automated Fingerprint Identification Systems (AFIS) and digital biometric databases. Hence, fingerprint classification is still an important part of modern forensic administration and criminal justice systems.

C. Fingerprint Collection and Examination Techniques

The reliability of fingerprint evidence is very much dependent on the scientific accuracy of the methods employed in its collection, preservation, examination and comparison. Fingerprint analysis is one of the most specialised branches of forensic science and requires technical knowledge, procedural accuracy and application of the standardised forensic procedures. Improper handling, contamination, or negligent examination of fingerprint evidence can negatively affect the reliability of forensic conclusions, thus undermining criminal investigations and judicial proceedings.[26]

The fingerprint examination generally involves a systematic search of the crime scene for surfaces that may contain fingerprint impressions and their identification. Objects examined for visible or latent fingerprints include weapons, fingerprints on glass surfaces, documents, electronic devices, furniture and vehicles by investigators and forensic experts. The proper management of the crime scene is important to avoid contamination, destruction or accidental alteration of fingerprint evidence during investigation.[27]

Fingerprint impressions recovered from crime scenes are usually classified into patent fingerprints, plastic fingerprints and latent fingerprints based on their mode of deposition and visibility. Patent fingerprints are those made by substances such as blood, grease, dirt or ink. These prints can be photographed directly, without further processing. Plastic fingerprints are three-dimensional impressions left on soft surfaces such as wax, soap, clay or wet paint. Such impressions preserve ridge details in either raised or indented form.

[26] Andre A. Moenssens, Fingerprint Techniques and the Theory of Identification, 39 VILL. L. REV. 1073, 1075–1102 (1994).
[27] K.S. NARAYAN REDDY & O.P. MURTY, THE ESSENTIALS OF FORENSIC MEDICINE AND TOXICOLOGY 64–68 (34th ed. 2017).

Photography and casting methods usually preserve these.[28] Latent fingerprints are the most important type of fingerprint evidence in criminal investigations. These fingerprints are normally invisible to the naked eye as they consist of natural secretions such as sweat and body oils, deposited on surfaces. Thus, they require special forensic techniques for their detection and visualisation. One of the most common techniques to develop latent fingerprints is powder dusting. Forensic scientists use this technique to apply fine powders to fingerprint residues with brushes or magnetic applicators. The particles of the powder adhere to the fingerprint residues, making the ridge patterns visible. Depending upon the nature and colour of the surface under examination different powders like black powder, aluminium powder, fluorescent powder and magnetic powder are used.[29]

To find fingerprints on porous surfaces such as paper, cardboard and untreated wood, chemical processing techniques are often used. Ninhydrin is a common reagent because it reacts with amino acids in the residue of sweat to produce a coloured impression of the fingerprint. In some forensic situations silver nitrate and iodine fuming are used to develop latent fingerprints. Superglue fuming, or cyanoacrylate fuming, is commonly used on non-porous surfaces such as glass, plastic and metal. This technique creates a white polymerised fingerprint impression that can be enhanced further with fluorescent dyes and alternate light sources.[30]

Technology has improved the way we do fingerprint exams today by leaps and bounds. Today, fingerprint impressions are clarified, enlarged and compared using digital imaging systems, alternate light sources and computer enhancement software. Automated Fingerprint Identification Systems (AFIS) permit law enforcement agencies to quickly and efficiently match fingerprints to large biometric databases.

[28] FRANCIS GALTON, FINGER PRINTS 45–60 (Macmillan & Co. 1892).
[29] Paripurnanand Verma, Role of Fingerprint Evidence in Criminal Investigation, 3 INDIAN J. FORENSIC SCI. 45, 45–53 (2011).
[30] NAT'L RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 136–45 (2009).

These technologies have significantly improved the ability of forensic investigators to identify suspects and to link accused persons to crime scenes.[31]

The scientific study of fingerprints is usually done with the ACE-V method, which stands for Analysis, Comparison, Evaluation and Verification. During the analysis phase the examiner evaluates the quality and quantity of the fingerprint impression. During the comparison stage, ridge characteristics and minutiae points are systematically matched against known samples. In the evaluation phase, it is determined if the fingerprints are from the same source. In the verification phase, another qualified examiner independently reviews the work for accuracy and to reduce the chance of human error.[32]

Despite advances in technology and science, fingerprint analysis still has many practical limitations. Partial prints, smudged impressions, poor quality ridge details, contamination and examiner bias may adversely affect the reliability of forensic conclusions. "Over-reliance on computerised systems may also carry the risk of technological errors and false matches. Thus, the evidentiary integrity of fingerprint evidence in the criminal justice administration must be rigorously upheld by adherence to procedural safeguards, scientific validation, and independent forensic examination.

V. LEGAL FRAMEWORK GOVERNING FINGERPRINT EVIDENCE IN INDIA

Fingerprint evidence occupies an important place in the Indian criminal justice system and is widely accepted as a reliable type of scientific evidence in criminal investigations and judicial proceedings. Fingerprint evidence is admissible, collected, examined and its evidentiary value is regulated through a combination of constitutional provisions, statutory enactments, procedural laws and judicial pronouncements. Indian courts have always acknowledged the importance of

[31] DAVID A. STONEY, Fingerprint Identification: Scientific Status, in MODERN SCIENTIFIC EVIDENCE 1–32 (David L. Faigman et al. eds., 2002).
[32] Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification, 95 J. CRIM. L. & CRIMINOLOGY 985, 987–1008 (2005).

fingerprint identification, while at the same time stressing procedural safeguards, constitutional safeguards and scientific reliability to forensic examination.[33]

The principal statutory provision dealing with expert opinion in respect of fingerprint examination is incorporated in the Bharatiya Sakshya Adhiniyam, 2023, which has repealed the Indian Evidence Act, 1872. The opinion of persons particularly skilled in foreign law, science and art, or in handwriting and finger print examination are relevant facts under Section 39 of the Bharatiya Sakshya Adhiniyam. This means fingerprint examiners are legally allowed to provide expert witness testimony in court on the identification and comparison of latent fingerprint impressions obtained from criminal investigations. However, courts generally require such expert opinions to be based upon proper forensic examination, scientific methodology and corroborative evidence.[34]

Fingerprints and biometric measurements are currently collected under the Criminal Procedure (Identification) Act, 2022, which replaced the colonial Identification of Prisoners Act, 1920. The law greatly expanded the powers of investigative authorities by allowing for the collection of fingerprints, palm impressions, footprints, photographs, iris scans, retina scans and other biometric measurements of convicts, detainees and certain classes of accused persons. The Act also provides for storage and preservation of biometric records in centralised databases for criminal investigation and identification purposes.[35] The Criminal Procedure (Identification) Act 2022 is a step towards making forensic investigations in India more modern and digital. This law helps in collecting and storing data like fingerprints and DNA from people who are arrested or convicted. It is a step forward in the modernisation and digitisation of forensic investigation systems in India.

The Act will help the police and other agencies to solve crimes quickly and accurately. The Criminal Procedure (Identification) Act 2022 will make it easier to catch criminals and bring them to justice. Police will be able to use this data to find and catch people

[33] Vepa P. Sarathi, Law of Evidence 412–18 (8th ed. 2020).
[34] The Bharatiya Sakshya Adhiniyam, No. 47 of 2023, § 39 (India).
[35] The Criminal Procedure (Identification) Act, No. 11 of 2022 (India).

who have committed crimes. This will help to make India a safer place. The Criminal Procedure (Identification) Act 2022 is a law, for India. This legislation will ease the use of digital biometric databases and Automated Fingerprint Identification Systems, or AFIS, by law enforcement to make criminal investigations more efficient and faster. But the expanded scope of biometric collection under the legislation has stirred serious debates over excessive state surveillance, misuse of personal data and lack of sufficient procedural safeguards to secure individual liberties.

Constitutional provisions are also important in regulating fingerprint evidence in the criminal proceedings. The Constitution of India has a rule that says people do not have to say things that can get them in trouble. This rule is in Article 20(3) of the Constitution of India. The Constitution of India says that nobody can be forced to testify against the person themselves.

The Supreme Court of India looked at this rule in the case of State of Bombay v. Kathi Kalu Oghad. The Supreme Court of India decided if it is okay to make people give their fingerprints. The Supreme Court of India said that fingerprints are like physical things that can be used as evidence. The Supreme Court of India also said that signatures that are used as examples are not the same as things people say. The Constitution of India and the decision in State of Bombay v. Kathi Kalu Oghad are important for the protection against self-incrimination, in the Constitution of India. Thus, compelling an accused to give his fingerprints does not offend the constitutional protection against self-incrimination under Article 20(3).[36]

This judgement continues to govern the constitutional framework relating to the collection of fingerprints in India. In the case of Selvi versus the State of Karnataka the Supreme Court looked into how forensic evidence collected. The Court discussed if it's okay to use techniques on people who do not want to participate. They emphasized that freedom and fair procedures are crucial during criminal investigations. The Court made it clear that liberty and fair procedures are important in investigations. The Selvi case highlighted the importance of liberty and fair procedures.

[36] State of Bombay v. Kathi Kalu Oghad, A.I.R. 1961 S.C. 1808 (India).

The Supreme Court said that involuntary forensic techniques are not allowed. The State of Karnataka was one of the parties in the Selvi case. The Selvi v. State of Karnataka case is about forensic evidence collection. In Selvi versus State of Karnataka personal liberty was discussed. The Supreme Court talked about evidence collection in Selvi, v. State of Karnataka.

The Court made a distinction between testimonial compulsion and collection of physical evidence such as fingerprints and reiterated the principles laid down in Kathi Kalu Oghad.[37] Although the case was primarily about narco-analysis, brain mapping and polygraph tests. The Supreme Court's acknowledgement of privacy as a fundamental right in Justice K.S. Puttaswamy v. Union of India has significantly influenced the current legal discussion on biometric data collection and surveillance. The judgement said that any limits on privacy rights must be legal, necessary and proportionate. The judgement also said that there must be procedures in place.

So, when law enforcement agencies collect and keep fingerprint and biometric data, they must do it in a way that is allowed by the rules that protect people's privacy and prevent the government from acting. The Digital Personal Data Protection Act, 2023 is a change in the law. This new law sets rules for how personal data's used, stored and protected in India. It is a framework that tells people and companies how to handle personal data, in India. The Digital Personal Data Protection Act, 2023 is important because it helps protect people's data in India. Fingerprints and other biometric identifiers are sensitive personal data that can disclose an individual's identity and behavioural patterns.

The legislation is based on principles such as lawful processing, purpose limitation, data minimisation and accountability of data fiduciaries, which are relevant vis-à-vis fingerprint databases maintained by law enforcement agencies. The law has some exceptions for investigations and law enforcement activities. Overall, the legislation makes the rules for biometric privacy and personal data stronger. This means that the people in charge of law enforcement activities and criminal investigations have to be

[37] Selvi v. State of Karnataka, (2010) 7 S.C.C. 263 (India).

more careful with data and biometric privacy. The legislation is good, for privacy and it helps with the responsible handling of personal data. It makes sure that personal data and biometric privacy are handled in a way.[38]

The courts in India have again stressed on the need to follow procedures when it comes to fingerprint evidence in criminal trials. This includes keeping a chain of custody using scientific methods for examination and having independent forensic experts review the evidence. The courts are being careful in cases where the conviction relies on fingerprint evidence. They often look for supporting facts to make sure the accused is guilty. This is to prevent convictions due to mistakes in collecting or examining fingerprints or due to procedural issues. In cases the courts want to be sure that the evidence is reliable.

They do not want people to be wrongly convicted. Therefore, they look for evidence to support the fingerprint evidence. This helps to ensure that justice is served. The courts have made it clear that they will be strict when it comes to fingerprint evidence. They want to make sure that the evidence is collected and examined properly. This will help to prevent convictions and ensure that the accused gets a fair trial. Therefore, the Indian legal system for fingerprint evidence stands as a testament to the continuous endeavour to harmonise effective criminal investigation with constitutional protections, forensic accountability, and individual rights.

The enactment of the Criminal Procedure (Identification) Act, 2022 has also been subjected to constitutional scrutiny on grounds relating to privacy, proportionality, and informational self-determination. The Internet Freedom Foundation challenged the constitutional validity of the Act before the Supreme Court of India under Article 32 of the Constitution, contending that the statute permits excessive and disproportionate collection and retention of biometric and personal data without adequate procedural safeguards or data protection mechanisms.

By an order dated 12 February 2024, the Supreme Court declined to entertain the writ petition directly under Article 32 and granted liberty to the petitioners to approach

[38] The Digital Personal Data Protection Act, No. 22 of 2023 (India).

the Delhi High Court under Article 226. Pursuant thereto, a constitutional challenge concerning the validity of the Criminal Procedure (Identification) Act, 2022 is presently pending before the Delhi High Court. The pending proceedings raise significant questions regarding the balance between investigative efficiency and the constitutional right to privacy recognised in Justice K.S. Puttaswamy v. Union of India. The ongoing litigation reflects the evolving jurisprudential debate surrounding biometric surveillance, state power, and data protection in India.

VI. JUDICIAL APPROACH AND IMPORTANT CASE LAWS RELATING TO FINGERPRINT EVIDENCE

In Indian judiciary fingerprint evidence has always been treated as an important type of scientific and expert evidence in criminal investigation and judicial proceedings. Because of the uniqueness and permanence of friction ridge patterns, fingerprint identification has been generally accepted by courts as a reliable means of establishing identity. However, the admissibility of fingerprint evidence in courts has always been accompanied by a caution about procedural safeguards, scientific accuracy, and the possibility of forensic errors. Indian courts have thus attempted to balance between the utility of scientific evidence and the constitutional rights of the accused and need for fair criminal trials.[39]

One of the earliest and an important judicial pronouncement relating to the fingerprint evidence is the case of State of Bombay v. Kathi Kalu Oghad. In this case Supreme Court considered the question whether compelling an accused to give his fingerprints or specimen signatures would amount to violation of the constitutional protection against self-incrimination under Article 20(3) of the Constitution of India. The Court held that fingerprints and specimen signatures are physical evidence not testimonial evidence and therefore do not compel an accused to be a witness against himself.[40] The judgement has upheld the constitutional validity of compulsory fingerprint collection and continues to be the governing law for biometric evidence in India.

[39] Paripurnanand Verma, Role of Fingerprint Evidence in Criminal Investigation, 3 INDIAN J. FORENSIC SCI. 45, 45–53 (2011).
[40] State of Bombay v. Kathi Kalu Oghad, A.I.R. 1961 S.C. 1808 (India).

The Supreme Court in Mohd. Aman v. State of Rajasthan observed that normally specimen fingerprints should be taken 'before or under the order of a Magistrate' to ensure procedural fairness and authenticity in the process of fingerprint identification. The Court emphasised the importance of maintaining proper safeguards while collecting specimen fingerprints so as to preserve the evidentiary reliability of forensic identification to ensure authenticity and reliability. The court noted that if proper procedures are not followed in the collection of fingerprints this may have an adverse impact on the evidentiary value of forensic evidence and create doubts as to its reliability in criminal trials.[41] In Surinder Singh v. State of Punjab, the Supreme Court recognised the evidentiary significance of fingerprint analysis and held that fingerprint evidence, when scientifically examined and corroborated with surrounding circumstances, constitutes a strong incriminating circumstance capable of linking the accused to the scene of crime.

The Court reaffirmed that expert scientific evidence such as fingerprint identification carries substantial probative value when supported by proper forensic examination and corroborative material on record. The Court has observed that expert opinion on fingerprints is of great probative value when scientific procedures are properly followed and when the evidence is corroborated by surrounding circumstances and corroborative material.[42] The ruling reaffirmed the importance of scientific analysis and expert testimony in a criminal trial.

Another important ruling is Musheer Khan alias Badshah Khan v. State of Madhya Pradesh, the Supreme Court emphasised the importance of scientific and forensic evidence in criminal adjudication and recognised that fingerprint impressions recovered from the crime scene constitute a significant incriminating circumstance when properly examined and corroborated by other evidence on record. The Court observed that forensic identification techniques, including fingerprint analysis, enhance the reliability of criminal investigation and aid in establishing the connection between the accused and the offence.

[41] Mohd. Aman v. State of Rajasthan, (1997) 10 S.C.C. 44 (India).
[42] Surinder Singh v. State of Punjab, (2014) 4 SCC 551 (India).

The Court noticed that fingerprint evidence, if scientifically examined and sufficiently supported, can be very helpful to the prosecution in criminal trials.[43] The constitutional aspects of the collection of forensic evidence have been dealt with extensively in Selvi v. State of Karnataka. The case mainly revolved around narco-analysis, brain mapping and polygraph tests but the Supreme Court gave an elaborate explanation on the distinction between testimonial evidence and physical evidence. The Court reiterated that the collection of fingerprints and other physical evidence does not violate Article 20(3) as such evidence is not testimonial in nature. The judgement also confirmed that individuals have the right to make their choices. This is really important in investigations. It said we need procedures and protections, in the constitution. Here are where personal autonomy, procedural fairness and constitutional safeguards are important.[44] Indian courts have said that fingerprint evidence is very important, but it is not always right. The courts have found problems with crime scenes that have been touched by many people and, with the way fingerprints are collected. Sometimes the people who look at the fingerprints can be. The fingerprints can be hard to read.

So, the courts are careful when they use fingerprint evidence to decide if someone is guilty. They usually want to see evidence that agrees with the fingerprints so they can be sure they are not making a mistake and sending an innocent person to jail. Indian courts want to use fingerprint evidence. They also want to make sure it is used in a way that is fair and accurate and that it is not the only reason someone is found guilty.[45]

The court case of Justice K.S. Puttaswamy v. Union of India is really important because it says that privacy is a right. This decision has had an impact on how courts think about using biometric evidence and fingerprint databases in Justice K.S. Puttaswamy v. Union of India. The idea of privacy, as a right is changing how we look at biometric evidence and fingerprint databases. The judgement did not deal directly with

[43] Musheer Khan alias Badshah Khan v. State of Madhya Pradesh, (2010) 2 SCC 748 (India).
[44] Selvi v. State of Karnataka, (2010) 7 S.C.C. 263 (India).
[45] Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification, 95 J. CRIM. L. & CRIMINOLOGY 985, 987–1008 (2005).

fingerprint evidence, but the Supreme Court was clear that any restriction of privacy rights had to meet constitutional standards of legality, proportionality, necessity and procedural safeguards.

The judgement therefore increased the legal scrutiny of law enforcement agencies' collection, storage and use of biometric information.[46] Thus, the judicial attitude towards fingerprint evidence in India is a mixture of scientific acceptance and constitutional caution. Although the courts have acknowledged fingerprint examination as a useful forensic science, there is still a need for procedural safeguards, expert verification, and constitutional protections against arbitrary and unreliable forensic practices. The judiciary is doing a balancing act. This is to protect the integrity of cases and the rights of people in the criminal justice system. The judiciary wants to make sure that the criminal justice system is fair to everyone. The main goal of the judiciary is to protect the integrity of cases and the rights of individuals, in the criminal justice system.

VII. SCIENTIFIC RELIABILITY AND EVIDENTIARY VALUE OF FINGERPRINT EVIDENCE

Fingerprints have been seen as a good way to solve crimes for a long time. They are very reliable. The reason we trust fingerprints is because of two ideas. One idea is that every person has fingerprints. No two people have the fingerprint patterns, not even brothers and sisters who are born at the same time. The other idea is that fingerprints stay the same for a person's life. Fingerprint patterns do not change, unless something bad happens to the skin like a serious cut or burn. This is what makes fingerprints so useful in investigations and, in courts. Fingerprints are a way to figure out who someone is.[47]

These characteristics have played a significant role in the general acceptance of fingerprint evidence in the criminal adjudication process. The science of fingerprints is mainly the study of the characteristics of friction ridges and minutiae points.

[46] Justice K.S. Puttaswamy v. Union of India, (2017) 10 S.C.C. 1 (India).
[47] FRANCIS GALTON, FINGER PRINTS 1–20 (Macmillan & Co. 1892).

Fingerprint experts examine ridge endings, bifurcations, dots, islands and other ridge formations to determine whether two fingerprint impressions were made by the same person. Modern forensic examination is generally based on the ACE-V methodology, which stands for Analysis, Comparison, Evaluation and Verification. This methodology is intended to provide a systematic examination and to reduce human error in the identification of fingerprints.[48]

The value of fingerprints in trials is really high because they can show a direct connection between someone who is accused of a crime and the actual crime. When we find fingerprints on things like guns, papers, cars, phones or other things that are connected to a crime it can really help the people who are trying to prove that someone is guilty. Fingerprints are often very convincing, in court because they are based on science not on what people think they saw or remember.

The technology we have today has made looking at fingerprints more reliable and useful.[49] Automated fingerprint identification systems (AFIS), biometric databases, digital imaging technologies, and computerised enhancement software allow investigators to compare fingerprint impressions quickly and accurately to large-scale databases. Such technologies have sped up and made more efficient criminal investigations while reducing some forms of manual error associated with traditional comparison methods.[50] Fingerprint evidence, while scientifically important, has its limitations and criticisms.

The other major concern is human error and examiner bias in the forensic examination. Fingerprint comparison often requires subjective interpretation by forensic experts, particularly in the case of partial, smudged or poor-quality latent fingerprints. There has also been controversy over scientific certainty of fingerprint identification. There are no universally accepted numerical standards for declaring a

[48] Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification, 95 J. CRIM. L. & CRIMINOLOGY 985, 987–1008 (2005).
[49] Vepa P. Sarathi, Law of Evidence 412–18 (8th ed. 2020).
[50] DAVID A. STONEY, Fingerprint Identification: Scientific Status, in MODERN SCIENTIFIC EVIDENCE 1–32 (David L. Faigman et al. eds., 2002).

fingerprint match.[51] Another major concern is contamination and mishandling of fingerprint evidence in criminal investigations. Things can go really wrong at crime scenes. If the area is contaminated that is a problem. The people in charge of collecting evidence may not do a good job.

They might make mistakes when they are collecting things. These mistakes can hurt the quality of the fingerprints they find. This means that the fingerprints may not be accurate. The police may then think someone committed a crime when they really did not. This is because the fingerprints are not good enough to prove anything. Contaminated crime scenes and bad collection techniques can lead to things. They can make it seem like someone is guilty when they are really not guilty. This is all because of mistakes with fingerprint impressions. Fingerprint impressions are very important. Mistakes, with fingerprint impressions can lead to identifications. Crime scenes need to be handled so that fingerprint impressions are good and accurate. In addition, excessive reliance on computerised systems can lead to technological errors, database inaccuracies, and false positive matches, thus affecting the evidentiary reliability of fingerprint analysis.[52]

In India, the judicial pronouncements have time and again highlighted the fact that fingerprint evidence cannot be looked upon as a matter of absolute truth and should be meticulously examined before it can be relied upon for conviction. Courts in criminal trials usually consider fingerprint evidence by requiring a proper chain of custody, scientific verification, corroborative evidence, and credible expert testimony. Mohd. Aman v. State of Rajasthan, the Supreme Court said, it is very important to follow the steps when we collect and look at fingerprint evidence. This is so that we can be sure that the fingerprint evidence is real and we can trust it.

The Supreme Court in Mohd. Aman v. State of Rajasthan wants to make sure that we do things correctly, so the fingerprint evidence is good. The fingerprint evidence has to be real and trustworthy. The Supreme Court in Mohd. Aman v. State of Rajasthan

[51] Jennifer L. Mnookin, The Validity of Latent Fingerprint Identification: Confessions of a Fingerprinting Moderate, 7 LAW, PROBABILITY & RISK 127, 127–41 (2008).
[52] NAT'L RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 136–45 (2009).

is talking about fingerprint evidence. How we need to be careful, with it.[53] The use of databases and digital fingerprint systems is getting bigger, and this is making people ask questions about privacy rights and how our data is protected. People also want to know who is responsible, for what happens with our data and digital fingerprints. Biometric databases and digital fingerprint systems are a deal, and we need to think about how they affect our privacy rights and data protection.

Retention and large-scale storage of fingerprint records by investigation agencies pose risks of unauthorised access, misuse of biometric information and excessive state surveillance. Scientific reliability of fingerprint evidence must therefore be balanced against constitutional safeguards, ethical considerations and procedural accountability within the criminal justice system.

Fingerprint science continues to be one of the most trusted forms of forensic identification. The ultimate evidentiary value of fingerprint science relies upon the accuracy of collection procedures, forensic examination, expert competency, and judicial evaluation. Therefore, continued scientific innovation, uniform forensic procedures, and strong legal protections are required to enhance the reliability and admissibility of fingerprint evidence to maintain public confidence in the criminal justice system.

VIII. SUGGESTIONS AND RECOMMENDATIONS

1. Development of Uniform Forensic Standards

The Government should frame the standards for the collection, preservation, examination and interpretation of fingerprint evidence uniformly across the country so as to ensure consistency and scientific reliability of forensic laboratories and investigating agencies. Standardised forensic procedures would reduce the possibility of human error, procedural irregularities and inconsistent forensic conclusions in criminal investigations.

2. Strengthening Forensic Infrastructure

[53] Mohd. Aman v. State of Rajasthan, (1997) 10 S.C.C. 44 (India).

State should leverage its existing forensic infrastructure by upgrading forensic laboratories with modern technologies such as Automated Fingerprint Identification Systems (AFIS), digital imaging tools, biometric databases and computerised forensic analysis software. An improved forensic infrastructure will greatly improve the speed, accuracy and efficiency of fingerprint examination in the criminal justice system.

3. **Special training of investigating officers and forensic experts**

Regular training programmes should be organised for police officers, forensic personnel and fingerprint experts on modern methods of fingerprint collection, techniques of preservation of crime scene, procedures of scientific examination and digital forensic technologies. Specialised training would enhance professional competence and reduce errors due to improper handling of forensic evidence.

4. **Mandatory Scientific Authentication Procedures**

The fingerprint examination should be compulsorily conducted based on standardised scientific procedures like the ACE-V process consisting of Analysis, Comparison, Evaluation, and Verification. Additional mandatory independent verification by qualified forensic experts should be done in order to diminish examiner bias and improve the reliability of forensic conclusions.

5. **The courts are becoming increasingly aware of forensic science.**

Proper training in forensic science, fingerprint examination procedures and scientific evidence evaluation should be provided to judicial officers, prosecutors and defence advocates. Better judicial comprehension of forensic methodologies would aid courts in properly scrutinising expert testimony and reducing the risk of wrongful convictions based upon unreliable forensic evidence.

6. **Defence Against Mistaken Identity**

Courts should be cautious in relying only upon fingerprint evidence to convict and should ordinarily look for corroborative evidence wherever possible. Miscarriages of justice arising from forensic inaccuracies or procedural irregularities can be avoided

only if the judiciary is able to scrutinize chain of custody, forensic procedures and quality of fingerprint impressions.

7. Strengthening privacy and data protection safeguards

Strict legal safeguards should apply to the collection, storage and use of fingerprint and biometric data to prevent misuse, unauthorised access, arbitrary surveillance and the violation of the right to privacy. Law enforcement agencies should be required to comply with principles of necessity, proportionality and accountability in their treatment of biometric information.

8. Regulation of Retention of Biometric Data

There should be clear statutory provisions on how long fingerprint records and biometric data can be kept by investigating agencies, particularly in cases where persons are acquitted, are juveniles, or have committed minor offences. Biometric data should not be retained for longer than necessary, as this may infringe on privacy rights and individual liberties.

9. Independent Audit of DNA Databases

Periodic independent audits should be conducted to examine the functioning, accuracy, and security of fingerprint databases maintained by law enforcement authorities." 6 Independent oversight mechanisms would help ensure lawful use of biometric information and prevent misuse of forensic technologies.

10. Promoting research and technological development

We must urge universities, forensic institutions and research organisations to conduct advanced research in fingerprint science, digital forensic technologies, error reduction mechanisms and biometric security systems. Scientific research and innovation would go a long way toward improving forensic reliability and accountability.

11. Forensic Administration Legislative Reforms

There is a need for comprehensive forensic legislation in India to regulate forensic procedures, accreditation of laboratories, qualifications of forensic experts and standards governing admissibility of scientific evidence. This kind of legislation

would enhance institutional accountability and the overall credibility of forensic science in the criminal justice system.

IX. CONCLUSION

The principles of uniqueness and persistence have ensured the application of fingerprint analysis as a means to establish the identity and involvement of an accused in a crime. Fingerprint science has become an indispensable part of modern criminal investigation and judicial procedure for its scientific validity and evidential significance. With the advent of forensic science and technology such as the Automated Fingerprint Identification System (AFIS), digital imaging technologies and other biometric databases, the efficiency of the forensic examination of fingerprints has greatly enhanced in the criminal process.

The Indian laws on fingerprints also demonstrate the high level of acknowledgement by the judiciary as well as the legislative branch with respect to the validity of forensic science and expert witness. While the Bharatiya Sakshya Adhiniyam, 2023 and the Criminal Procedure (Identification) Act, 2022 allow collecting and analysing fingerprints, as evidence the courts have again stressed the need to follow procedures ensure fingerprint analysis is based on science and protect people's rights when it comes to fingerprint analysis. Among the notable cases, one can distinguish State of Bombay v. Kathi Kalu Oghad, Mohd. Aman v. State of Rajasthan, and Selvi v. State of Karnataka.

However, despite a rather broad acceptance and application, fingerprint science is still vulnerable to criticism and some challenges related to the potential flaws in the practice of collecting fingerprints, examination of evidence, and other aspects of criminal proceedings. For example, examiner's bias, incorrect procedures of fingerprint collection, contamination of a crime scene, inadequate fingerprints, and errors associated with the use of technology can undermine forensic findings and lead to wrongful conviction. In addition, a lack of standards of forensic practices and independent verification shows the need for ensuring forensic responsibility in the criminal process.

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The use of biometric technologies and fingerprinting databases has raised additional problems associated with issues related to protection of people's privacy and data security, as well as the issue of excessive state intrusion into a person's private life. Given the constitutional protection of a person's privacy as established in the Supreme Court decision in Justice K.S. Puttaswamy v. Union of India, it is evident that fingerprint database and other similar actions should satisfy several criteria, namely legality, necessity, and proportionality. Moreover, the adoption of the Digital Personal Data Protection Act, 2023 indicates the significance of ensuring the regulation of processing personal data in a new technological environment.

Therefore, even though the science of fingerprinting is accepted as one of the most valid and reliable tools of forensic identification, its continued use in criminal trials should be governed by proper procedures, independent scientific review, judicial oversight, and respect for a person’s constitutional rights.

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