INTERNATIONAL JOURNAL OF HUMAN RIGHTS LAW REVIEW
An International Open Access Double Blind Peer Reviewed, Referred Journal

Volume 4 | Issue 3 | 2025 Art. 56

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Recommended Citation
Arleen Kaur Walia, *The Role of Forensic Science in Criminal Investigations*, 4 IJHRLR 844-871 (2025).
Available at www.humanrightlawreview.in/archives/.

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Manuscript Received	Manuscript Accepted	Manuscript Published
04 June 2025	05 June 2025	06 June 2025

ABSTRACT

Forensic science is very important in the issue of crime control. It gives scientific analysis to the legal processes in the criminal justice system. The forensic applications definitely gained ground over the years, yet getting them into the criminal justice system of India continues to be a challenge. The study thus aims to critique the legal ramifications regarding the application and admissibility of forensic evidence in the Indian legal system, especially concerning the Bharatiya Sakshya Adhiniyam and Bharatiya Nagarik Suraksha Sanhita, both of which came into being in 2023. It will also examine the forensic techniques of DNA analysis, ballistics, toxicology, and digital forensics in terms of their practicalities, merits, and effectiveness in crime-solving. Further, the scope of the research will include the identification of issues and challenges of operation and basic infrastructure of forensic science laboratories in India facing delay, lack of trained manpower, etc., and other gaps into procedures of functioning of forensic laboratories. Another interest concerning the study involves judicial trend analysis on the dependency and admissibility of forensic evidence in criminal trials. From the findings, therefore, it points to the fact that these very concrete reforms include laboratory infrastructure improvement, standardized forensic practices, revised training of law enforcement and judicial officers, and programs aimed at legal reforms for deeper integration of forensic sciences into the justice system.

KEYWORDS

Forensic Science, Criminal Investigations, Indian Evidence Act, DNA Analysis, Forensic Laboratorie.

1. INTRODUCTION

Fifth-generation forensic science and law has brought about the

most promising revolution in the delivery of justice-the intersection of both in India. The application of forensic science principles i.e., scientific principles to an investigation of a crime dramatically changes how evidence is collected, tested, and presented in a court of law. It forms a link between science and the law so that the decision of an investigator or judge would make inferences based on objective empirical data. With the continuous improvement in the complexity of criminal behaviors and the advanced technology, the evidence collected in the form of eyewitnesses or oral confession cannot be relied on entirely and are being supplemented or sometimes replaced by forensic evidence. Of course, the very need to change the evidentiary mechanism is mainly represented, in the Indian perspective, by the ever-increasing case loads, demand for disposal in time, and public expectation of more transparency and accountability in delivering criminal justice services.[1]

1.1. Background of Forensic Science in Criminal Investigations

The concept of forensic science in India came into being during the colonial period and its early development dated back to the establishment of the Chemical Examiner's Laboratory in Madras in 1849. Gradually, this could develop into a national network of forensic institutions, including the Central Forensic Science Laboratory (CFSL) itself and several State Forensic Science Laboratories (SFSLs), all integrated under the administrative control of Directorate of Forensic Science Services (DFSS), Ministry of Home Affairs. In these institutions, multidisciplinary science with applied tools has been employed for scientific analysis of all kinds of forensic evidence.[2] The investigation of any crime in India is governed by the Bharatiya Nagarik Suraksha Sanhita, 2023 (BNSS), which delimits the powers of the police for the investigation of offences (for example, Sections 173 to 196). Forensics, therefore, becomes relevant from the action of collection-making evidence (search and seizure under Sec.103 BNSS) till the filing of the charge sheet (under Sec.193 BNSS). The use of scientific techniques in the investigation is supposed to be supported by judicial pronouncements laying enhanced reality on the evidentiary value of forensic inputs. Notably, institutions like the National Institute of Criminology and Forensic Science (NICFS) are prime movers in the area of research and capacity-

[1] Harendra Nath Singh, "Crime Scene Investigation" International Journal of Science and Research, 2021 *available at*: https://www.researchgate.net/publication/356283044_CRIME_SCENE_INVESTIGATION (last visited June 1, 2025).

[2] admin, "Growth of Forensic Science in India" Sandip University, 2024 *available at*: https://facultyblog.sandipuniversity.edu.in/growth-of-forensic-science-in-india/ (last visited June 1, 2025).

building. Forensic science has gained acceptance slowly and steadily all over the world for the effective resolution of salient cases extending to terrorism, sexual assaults, and cyber crime. DNA fingerprinting, introduced under the technical guidance of the Centre for DNA Fingerprinting and Diagnostics (CDFD), has become a game changer in the solution of paternity disputes, rape, and unidentified bodies. A forensic tool was once considered ancillary to investigations, but now they are inseparable. They have a direct bearing not only on the strategy of investigations but also on the strategy of prosecutions.

1.2. Value of Forensic Science in the Indian Legal System.

Forensic science has long been an acceptable source of information legally in India with regard to the Bharatiya Sakshya Adhiniyam, 2023. Admissibility of expert opinion is addressed, more to the point, in Section 39, which states that where an opinion has to be formed from the court upon a point of science then the view of a person or persons specially skilled in such science is a relevant fact. This basically stars the process of steady incorporation by the Courts of forensic reports and expert testimony in proceedings before them. On the other hand, the provisions of Section-329 of the BNSS allow the Court to admit the reports of any specialized government scientific experts into evidence without those experts giving oral deposition, and the Court is still empowered to call upon the expert for cross-examination when necessary. [3]

This sustains the evidentiary link in that forensic science provides data that could, in principle, be empirically verified, and hence reduce, if not eliminate, dependence on human memory or perception. In that way, these human conditions have proven to be immensely dubious. Therefore, it states that in any case pertaining to Section 64 of the Bharatiya Nyaya Sanhita, 2023 (rape), biological samples collected from the victim's body and clothing-such as other materials like semen stains and positive DNA profiles-would matter for corroboration. Forensic examination of bullets serves repeated functions in murder prosecutions under Section 101 BNS, thus rendering much scientific value in pinpointing the weapon used in conjunction with crime scene reconstruction.[4]

1.3. Objectives of the study

[3] Jeevan Shekar, "The Admissibility of Scientific Evidence in Bharatiya Sakshya Adhiniyam, 2023 and the Need for an Indian Daubert" *available at*: https://papers.ssrn.com/sol3/Delivery.cfm/5052611.pdf?abstractid=5052611&mirid=1 (last visited June 1, 2025).
[4] Ibid.

1. To study the law with respect to the use and admissibility of forensic evidence in connection with criminal investigation and trial under Indian law especially with reference to Bharatiya Sakshya Adhiniyam, 2023, and the Bharatiya Nagarik Suraksha Sanhita, 2023.

2. To analyze the adoption of different forensic sciences like DNA analysis, ballistics, toxicology etc., and digital forensics in practice for doing justice in criminal cases across India.

3. To study the institutional infrastructure and operational obstacles to forensic science laboratories and investigative agencies in India, including time delays, shortage of trained personnel, and gaps in procedures.

4. To investigate the case law and landmark judgments on the legal admissibility, reliability, and importance of forensic evidence in criminal trials.

5. To make recommendations with regard to legal, administrative, and policy approaches that could stand to enhance the smooth functioning of forensic science in the criminal justice machinery in India but without compromising on their transparency and scientific rigor.

1.4. Research Questions

1. How far have the laws going by the former collections to date been in India concerning admissibility and evaluation of forensic evidence with the criminal investigations and prosecutions?

2. What is the percentage or measure of efficiency with which the forensic sciences techniques are being used by law enforcement agencies in India, regarding investigation and prosecution of crimes?

3. What are the most important limitations and challenges in the Indian context that forensic institutions and investigators are facing today?

4. What precedent has India laid in landmark criminal cases regarding the interpretation and acceptance of forensic evidence by Indian courts, and what standards have been set for his admissibility?

5. What changes in law, institution, and policies are necessary for further strengthening the role of forensic science in criminal justice administration in India?

1.5. Research Methodology

The methodology is doctrinal and normative per se, drawing itself fully on the sources of statute, case law, commentary, and journal articles on various aspects of forensic science which are aiding criminal investigation in India. It involves critically analyzing secondary sources, including various legal journals, forensics organizations' reports, the reports of the Law Commission, and judicial pronouncements, for knowledge of the existing framework of law and judicial trends. This is the way by which this research would provide an understanding of the concepts of legal principles of forensic evidence while evaluating the gaps, challenges, and the required reforms in the Indian legal investigation systems.

1.6. Review of Literature

Sood, A., & Kashyap, S. (2018). [5] This study explores the administration of criminal justice in India and the crucial role forensic science plays in the investigative process. The authors discuss how forensic science supports criminal justice by providing objective evidence, helping authorities solve cases efficiently and accurately. The paper also highlights the challenges in forensic application in India and suggests improvements.

Kothari, P. (2023). [6] In this paper, Kothari examines the evolving role of forensic science in the Indian criminal justice system. The author provides insights into various forensic techniques, their impact on criminal investigations, and how they contribute to a more effective justice system in India. It emphasizes the need for better integration and standardization of forensic practices.

Khan, G. F., & Ahad, S. (2018). [7] This article addresses the significance of forensic science in criminal investigations, focusing on its admissibility within the Indian legal system. Khan and Ahad critically analyze how forensic evidence is used in courtrooms and its reliability, providing a perspective on the future role of forensic science in Indian criminal justice.

Tewari, R. K., & Ravikumar, K. V. (2000). [8] Tewari and

[5] Sood, A., & Kashyap, S. (2018). Administration Of Criminal Justice And Role Of Forensics In India: A Study. International Journal of Innovative Research and Advanced Studies, 5(4), 69-73.
[6] Kothari, P. (2023). Exploring the Role of Forensic Science in Indian Criminal Justice System. *available at* SSRN 4565177.
[7] Khan, G. F., & Ahad, S. (2018). Role of Forensic Science in Criminal Investigation: Admissibility in Indian Legal System and Future Perspective. International Journal of Advance Research in Science and Engineering, 7(4), 220-234.
[8] Tewari, R. K., & Ravikumar, K. V. (2000). History and Development of

Ravikumar's paper provides an in-depth historical account of the development of forensic science in India. The authors trace the origins of forensic practices in the country and discuss significant milestones in the establishment of forensic laboratories and the professionalization of forensic experts.

Shali, S. K. (2019). [9] In this paper, Shali explores the various roles forensic science plays in criminal investigations, highlighting its impact on solving cases, enhancing the accuracy of evidence, and assisting in the judicial process. The study also discusses the challenges faced by forensic science in India and suggests measures to improve its effectiveness in criminal investigations.

2. HISTORICAL EVOLUTION OF FORENSIC SCIENCE IN INDIA

The evolution of forensic science in India is closely intertwined with the establishment of modern policing, colonial modes of administration, and the changing requirements of the Indian criminal justice system. While it started with primitive methods utilized by the police, it has now become a multidisciplinary, evidence-led method of investigation of crime. India has made remarkable progress over the decades in establishing institutional capacities, legislating relevant laws, and incorporating forensic tools in criminal procedure. The legal and procedural frameworks for this transformation are largely contained in the Bharatiya Sakshya Adhiniyam, 2023 and the Bharatiya Nagarik Suraksha Sanhita, 2023, which cover expert opinion, admissibility of evidence, and investigation procedure.

2.1. Early Developments in Forensic Science

The roots of forensic science in India were formed during British rule, where medico-legal investigation, chemical analysis, and toxicology received the major attention. The very first Chemical Examiner's Laboratory came into existence in Madras (now Chennai) in 1849 with an objective to test substances in case of poisoning. This pattern was followed in Calcutta and Bombay as well. These early labs were essentially concerned with the cases of suspicious deaths, determination of alcohol and narcotic contents, and testing for toxic material.[10]

In the late 19th and early 20th centuries, forensic medicine obtained formal status in India. Police forces started working with

Forensic Science in India. Journal of Postgraduate Medicine, 46(4), 303-308.

[9] Shali, S. K. (2019). The Role and Impact of Forensic Science in Criminal Investigation. *available at* SSRN 3393324.

[10] "+Bioline International Official Site (site up-dated regularly)," *available at*: https://www.bioline.org.br/request?jp00100 (last visited June 2, 2025).

medical professionals to obtain post-mortem reports and crime scene analysis. While forensic science was narrow in scope and methodology at this time, it provided the basis for systematic scientific inquiry.[11]

The Bharatiya Sakshya Adhiniyam, 2023, specifically Section 39, added to the law's admissibility of expert evidence, including scientists', doctors', and technicians' opinions. It was a decisive judicial recognition of science's part to play within judicial process. It added statute-based provision in terms of its permitting courts to admit expert views from forensic analysts for purposes of ascertaining facts involving causation of death, identification, handwriting, and chemical constitution — something still key to the law on admissibility of forensic evidence.

2.2. Set Up of Forensic Science Laboratories in India

After independence, India saw considerable institutional growth in forensic science capacity. The government felt the need for specialized scientific assistance to police forces, especially with the growth in crime and the advancement of technology. Accordingly, the Central Forensic Science Laboratory (CFSL) was inaugurated in Calcutta in 1957 under the Bureau of Police Research and Development (BPRD). Thereafter, CFSLs were established in Hyderabad, Chandigarh, and New Delhi to cater to regional needs.

Concurrently, several State Forensic Science Laboratories (SFSLs) were set up under the concerned State Home Departments for the purpose of offering decentralized and prompt forensic assistance to state police organizations. These laboratories offer a broad spectrum of forensic sciences ranging from biology to toxicology.

One of the most important legislative support mechanisms was provided by Section 329 of the Bharatiya Nagarik Suraksha Sanhita, 2023, which provides for the acceptance of reports by government scientific experts, including forensic analysts, as evidence in court without oral testimony in all cases. This provision simplifies the judicial process and emphasizes the evidentiary value of forensic reports.

Also, organizations like the National Institute of Criminology and Forensic Science (NICFS), which was set up in 1972 under the Ministry of Home Affairs, are crucial in training, research, and capacity building. The Directorate of Forensic Science Services

[11] Om P Murty, "Uniform guidelines for postmortem work in India" Diva Enterprises Private Limited, 2013 *available at*: https://www.researchgate.net/publication/260182850_Uniform_guidelines_for_postmortem_work_in_India (last visited June 2, 2025).

(DFSS) was subsequently established to coordinate and standardize forensic science procedures at the national level.

In order to present an overview of the institutional development, the subsequent table indicates the important milestones in setting up forensic science facilities in India:

Year	Institution/Development	Significance
1849	Chemical Examiner's Laboratory, Madras	First forensic lab in India for toxicology and chemistry
1957	Central Forensic Science Laboratory (CFSL), Calcutta	First CFSL; expanded scope beyond toxicology
1972	National Institute of Criminology and Forensic Science (NICFS)	Training and research institution for forensic professionals
2002	Directorate of Forensic Science Services (DFSS), MHA	Coordination and policy body for national forensic services

3. INSTITUTIONS AND INFRASTRUCTURE IN INDIA

The effectiveness of forensic science in India is in turn dependent on the supporting institutions, laboratories, centres of training, and investigative systems that facilitate scientific investigation in criminal cases. A strong forensic infrastructure is absolutely necessary not just for rapid evidence examination but also for chain of custody maintenance and criminal justice system integrity. India's forensic infrastructure is a multi-layered system with Central and State laboratories, specialized educational institutions such as the National Forensic Sciences University (NFSU), and functional coordination with police and inquiry agencies. In spite of the institutional arrangement on the ground, a number of infrastructural, operational, and procedural issues remain which constantly inhibit the maximum utilization of forensic science in the investigation process.[12]

[12] Srishti, "The Impact of Forensic Science on the Legal System in India" Heighten Science Publications Corporation, 2025 *available at*: https://www.researchgate.net/publication/389483356_The_Impact_of_Forensic_Science_on_the_Legal_System_in_India (last visited June 3, 2025).

3.1. Central and State Forensic Science Laboratories

The Indian forensic system is supported by a chain of State Forensic Science Laboratories (SFSLs) and Central Forensic Science Laboratories (CFSLs). These laboratories examine physical, biological, chemical, and electronic evidence unearthed during criminal investigations. The Central Forensic Science Laboratories fall under the Directorate of Forensic Science Services (DFSS), which is under the administrative control of the Ministry of Home Affairs (MHA), Government of India. The CFSLs are strategically placed at Hyderabad, Chandigarh, Kolkata, Guwahati, Pune, and Bhopal. These labs offer specialized services in the form of DNA analysis, cyber forensics, identification of narcotics, handwriting and signature verification, and ballistic testing. Concurrently, State Forensic Science Laboratories (SFSLs) are run and controlled by the concerned State Governments. SFSLs provide forensic facilities to state police and judiciary. Both CFSLs and SFSLs' functions are legally aided by Section 329 of Bharatiya Nagarik Suraksha Sanhita, 2023, which allows government-nominated expert forensic reports to be admitted in evidence without oral examination, unless specified by the court. To meet regional needs and alleviate pressure on CFSLs and SFSLs, Regional Forensic Science Laboratories (RFSLs) and Mobile Forensic Units (MFUs) have also been implemented in a few states. These satellite facilities ensure timely and localized forensic service, especially from rural or far-flung crime scenes.

3.2. National Forensic Sciences University (NFSU)

Recognizing the urgent need for formal education and research in forensic disciplines, the Government of India established the National Forensic Sciences University (NFSU) in 2020 by upgrading the former Gujarat Forensic Sciences University through the National Forensic Sciences University Act, 2020. Headquartered in Gandhinagar, Gujarat, NFSU is the world's first and only university dedicated exclusively to forensic sciences and allied fields.

NFSU fulfills many functions: it provides academic education on forensic science, cyber security, criminology, and homeland security; carries out advanced-level research; and offers training to law enforcement personnel, members of the judiciary, and forensic experts. Its association with CFSLs and SFSLs improves both theoretical knowledge and practical application of forensic instruments in actual cases. Also, NFSU encourages capacity building with short-term certificate courses and postgraduate diploma programs, thus closing the knowledge and skill gap widely existing among the existing law enforcement officers.

Establishment of NFSU has immensely made forensic practice standardized and professional across India.

3.3. Police and Investigative Agencies' Role

Police and investigative authorities are the first to respond in the majority of criminal cases and are an integral part of the collection, preservation, and production of forensic evidence. According to Section 175 of the Bharatiya Nagarik Suraksha Sanhita, 2023, the police have the authority to investigate cognizable offences, which also comprises the authority of physical evidence collection from crime scenes. It is at this point in time that coordination between the investigating officer and forensic staff takes on a vital role. It is the duty of the Investigating Officer (IO) to maintain the integrity of the crime scene and prevent the contamination, misplacement, or mishandling of evidence. Coordination with forensic scientists in the course of scene-of-crime visits, autopsy inspections, and chemical analyses is important to create a chain of custody. Such cooperation shall be subject to procedural requirements under Section 185 BNSS (police officer search) and Section 329 BNSS (scientific experts' report) for ensuring court admissibility and credibility of forensic evidence. Further, such agencies as the Central Bureau of Investigation (CBI) and National Investigation Agency (NIA) regularly avail themselves of CFSL services for convoluted cases of national security, terrorism, cybercrime, and white-collar crime. Such high-level forensic interventions as specialized DNA sequencing, voice spectrography, digital forensics, and forensic accounting are often needed by these specialized agencies.[13]

4. FORENSIC SCIENCE TECHNIQUES USED IN CRIMINAL INVESTIGATIONS

Forensic science utilizes a wide range of scientific methods and instruments to support criminal investigations through suspect identification, crime scene reconstruction, and confirmation of facts. In India, these methods are applied by forensic scientists, law enforcement officials, and judicial authorities in accordance with procedural legislation like the Bharatiya Sakshya Adhiniyam, 2023 and the Bharatiya Nagarik Suraksha Sanhita, 2023. The incorporation of these methods into the criminal justice system has immensely enhanced evidence-based adjudication.

4.1. DNA Profiling and Its Uses

DNA profiling or genetic fingerprinting is one of the most accurate techniques of individual identification. It finds application in

[13] Neeraj Chaudhari, “Enhancement of investigation procedure under Bharatiya Nagarik Suraksha Sanhita” Times of India, 30 April 2024.

sexual assault cases, paternity cases, murder, and missing persons cases. According to Section 52 of the Bharatiya Nagarik Suraksha Sanhita, 2023, biological samples (e.g., blood, semen, saliva) from the accused can be taken by the police for the purpose of DNA examination with the help of a medical practitioner.[14]

India legalized the law governing DNA testing by way of the DNA Technology (Use and Application) Regulation Bill, which, while not yet passed into law, seeks to regulate the application of DNA evidence during judicial proceedings. The Bharatiya Sakshya Adhiniyam, 2023, Section 39, allows expert opinion on DNA reports to be received as scientific evidence.

4.2. Fingerprinting and Identification

Fingerprinting is a very old and reliable method applied in criminal investigations. It identifies the presence or individuality of suspects at the scene of the crime. Fingerprinting's legal foundation comes in the form of the Identification of Prisoners Act, 1920, lately substituted by the Criminal Procedure (Identification) Act, 2022, whereby the law recognizes the right to take biometric and physical measurements, including fingerprints, of convicted persons and accused persons for purposes of investigation and adjudication. The Fingerprint Bureau of the National Crime Records Bureau (NCRB) has a central database to match and retrieve fingerprint records of states.

4.3. Ballistics and Firearm Analysis

Ballistics entails the examination of firearms, cartridges, and the action of projectiles. Forensic ballisticians identify the weapon employed, bullet trajectory, and comparison of bullets with guns. This method is essential in homicide, terrorism, and armed robbery investigations. Ballistic examination is judicially accepted under Section 39 of the Bharatiya Sakshya Adhiniyam, 2023, to permit the evidence of firearm experts to be accepted in court. Ballistic experts' reports are usually accepted under Section 329 BNSS, which deals with government scientific experts.[15]

4.4. Toxicology and Chemical Analysis

Toxicology involves the detection of poisons, drugs, and alcohol in

[14] Astha Srivastava, "ANALYZE THE ROLE OF FORENSIC EVIDENCE LIKE MEDICAL REPORT AND DNA IN RAPE CASES » Lawful Legal" Lawful Legal, 2025 *available at*: https://lawfullegal.in/analyze-the-role-of-forensic-evidence-like-medical-report-and-dna-in-rape-cases/ (last visited June 3, 2025).

[15] J Komenda, "2458 PDFs" ResearchGate *available at*: https://www.researchgate.net/topic/Forensic-Ballistics/publications/3 (last visited June 4, 2025).

biological samples. Forensic toxicologists analyze substances related to suspicious deaths, poisonings, drug overdose, and driving under the influence (DUI) offenses. Chemical analysis is also done to analyze substances recovered from crime scenes. Government Chemical Examiners are hired under Section 329 of the BNSS and their reports are court-admissible. Section 51 BNSS also allows medical examination of the accused during suspected drug intoxication or drug-offence cases.[16]

4.5. Forensic Pathology and Autopsy

Forensic pathology entails post-mortem examination to ascertain the cause, manner, and time of death. Autopsies, performed by authorized medical officers, are an important aspect of unnatural death investigations. According to Section 194 of the BNSS, police must report and seek post-mortem in suspicious or unnatural death. Post-mortem reports are receivable as expert opinion under Section 39 of the Bharatiya Sakshya Adhiniyam, and pathologists can be called for oral examination when necessary under the court's instructions.

4.6. Digital Forensics

Digital forensics is a specialized investigation area under cybercrime, financial fraud, and terrorism. It entails the retrieval, storage, and examination of digital data from computers, handsets, networks, and other electronic equipment. Provisions under the Information Technology Act, 2000, like Section 79A, authorize specific forensic laboratories to deal with digital evidence. Digital forensic specialists are often engaged in recovering deleted files, tracking IP addresses, and decrypting communication data.

4.7. Forensic Anthropology and Odontology

Forensic anthropology is concerned with identification of skeletal remains, age, sex, and stature estimation, especially in the case of mass disasters or decomposed bodies over many years. Forensic odontology, however, encompasses the analysis of dental evidence to identify or evaluate bite mark injuries. Both are admissible under Section 39 of the BSA as expert opinions. These fields are increasingly used in complex criminal cases involving dismembered remains or when visual identification is not possible.

5. LEGAL FRAMEWORK GOVERNING FORENSIC SCIENCE IN

[16] Matteo A Sacco et al., “The Role of Toxicology Investigations in Overdose Deaths - PMC,” 17 Cureus.

INDIA

The legal basis of the application of forensic science within criminal investigations and trials in India is rooted in laws like the Bharatiya Sakshya Adhiniyam, 2023, the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023, and a number of other specialized acts. The laws define the treatment of forensic evidence, its admissibility in courts, and its application in courts so that scientific evidence is at the center of the criminal justice system. Yet, even with the legislative backing, there are still obstacles in fully incorporating forensic science into legal processes, which continue to prevent it from effectively solving cases and upholding justice.

5.1. The Bharatiya Sakshya Adhiniyam, 2023

The Bharatiya Sakshya Adhiniyam, 2023, is one of the core legal tools in the Indian judicial system for the control of evidence. Forensic science, as a science, has an important role to play in this legal tool, mainly through its provisions concerning the admissibility of expert opinion and scientific evidence. Section 39 of the Bharatiya Sakshya Adhiniyam directly deals with the position of experts in a court of law. According to this section, whenever the court requires to take an opinion on an issue connected with science, art, or handwriting, it is entitled to call for an expert. Section 39 allows forensic experts to provide evidence in court regarding issues falling within their expertise, i.e., DNA profiling, ballistics, toxicology, and pathology. Section 40 provisions for the evidence of physical things, such as forensic reports, as long as they are brought by an acknowledged expert. Additionally, Section 47 offers provisions for the admissibility of any evidence concerning the identification of handwriting or any documents, which is important in cases involving documents and signatures. The Bharatiya Sakshya Adhiniyam provides that expert evidence, including forensic reports, must be presented in a manner that meets the legal standards of relevance, reliability, and the chain of custody. Courts must evaluate the credibility of forensic evidence based on its accuracy, validity, and the qualifications of the expert providing the testimony.[17]

5.2. Forensic Science in Indian Bharatiya Nagarik Suraksha Sanhita

The Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023, is another critical legal instrument governing the use of forensic

[17] Jeevan Shekar, "The Admissibility of Scientific Evidence in Bharatiya Sakshya Adhiniyam, 2023 and the Need for an Indian Daubert" *available at*: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5052611 (last visited June 4, 2025).

science in India, particularly in criminal investigations and the procedural handling of evidence. Under Section 51 BNSS, the police are empowered to take bodily samples from a person accused of a crime, i.e., blood, semen, saliva, hair, and other biological samples, for analysis by forensic scientists. It places forensic science within the investigative process and authorizes authorities to employ sophisticated methods, like DNA fingerprinting, to establish or disprove the involvement of suspects in crimes. Section 329 BNSS is also central to the incorporation of forensic science in the judicial process. It provides for the admissibility of forensic expert reports (e.g., toxicological or ballistic reports) without the physical presence of the expert in court. This section accelerates the judicial process by enabling the admissibility of written forensic reports as evidence, subject to their being from a government-appointed expert. In addition, Section 180 BNSS permits the police to take witness statements and collect forensic evidence in the crime scene. Forensic experts' collaboration is essential at this stage to ensure that the evidence collected maintains the integrity of the evidence, especially in instances of complex scientific evaluation like digital forensics or post-mortem examination.[18]

5.3. Admissibility of Forensic Evidence in Court

Forensic evidence is very important in criminal trials as it offers scientific evidence to prove or disprove allegations. The Bharatiya Sakshya Adhiniyam, 2023, and the BNSS regulate the admissibility process of forensic evidence in court. Forensic science methods like DNA profiling, fingerprinting, toxicology, and ballistic analysis are expert evidence and can be admitted in court under the relevant legal provisions. Admissibility of forensic evidence is based on its relevance and reliability as stipulated under Section 39 of the Bharatiya Sakshya Adhiniyam. The evidence should comply with the "relevance" standard, in that it has to directly link to the case. Section 142 of the Bharatiya Sakshya Adhiniyam further stipulates that any scientific report or expert testimony must be generated by a trained expert whose opinions are founded upon recognized scientific principles for it to be admissible. Section 63 of the Bharatiya Sakshya Adhiniyam also applies to admissibility of electronic evidence, which is of vital importance in the era of cybercrime. The section permits electronic records, including computer data, mobile data, and digital storage data, to be led in evidence in a court of law, subject to authentication by a specialist and compliance with certain legal

[18] "The Bharatiya Nagarik Suraksha (Second) Sanhita, 2023," PRS Legislative Research *available at*: https://prsindia.org/billtrack/the-bharatiya-nagarik-suraksha-second-sanhita-2023 (last visited June 4, 2025).

conditions.

5.4. The Forensic Expert as a Witness

Forensic scientists have a critical role to play in offering specialized expertise in the course of trials. According to Section 39 of the Bharatiya Sakshya Adhiniyam, forensic scientists, irrespective of areas of specialization such as DNA profiling, toxicology, or pathology, can be ordered by the court to provide opinion on issues in their area of expertise. Forensic scientists should present scientific facts in a format that is accessible to the court and offer unbiased opinions on their findings. Section 329 BNSS provides the court with the facility of accepting the forensic expert's report without their physical presence, unless otherwise directed by the court. This facilitates the ease of the judicial process, particularly in cases involving expert testimony which would otherwise be time-consuming. Nonetheless, courts can still call forensic experts to give evidence in intricate cases or where there are objections regarding the veracity or credibility of the forensic report. Forensic experts need to follow professional ethics and standards. Their expert opinion plays a pivotal role in determining the course of criminal trials, particularly those involving sophisticated scientific evidence. In some cases, cross-examination of forensic experts is important because defense attorneys will question the method, outcome, or qualifications of the expert.[19]

6. CHALLENGES AND LIMITATIONS IN THE USE OF FORENSIC SCIENCE IN INDIA

Though its importance in contemporary criminal investigations is growing, the application of forensic science in India still encounters several systemic issues. Though the legal system through legislation such as the Bharatiya Sakshya Adhiniyam, 2023 and Bharatiya Nagarik Suraksha Sanhita, 2023 offers a foundation for forensic evidence, practical constraints like poor infrastructure, non-standardization, and legal uncertainty limit its effectiveness. The infusion of scientific methods into the judicial and investigative process still needs to be strengthened considerably in both institutional and procedural terms.

[19] "Is expert testimony an important aspect of the Indian legal system, and how are Sections 39 and 40 of the Bharatiya Sakshya Adhiniyam, 2023 relevant to it?," Legal Wires - World leaders in legal education and research, 2018 *available at*: https://legal-wires.com/lex-o-pedia/is-expert-testimony-an-important-aspect-of-the-indian-legal-system-and-how-are-sections-39-and-40-of-the-bharatiya-sakshya-adhiniyam-2023-relevant-to-it/ (last visited June 4, 2025).

6.1. Shortage of Standardization and Training

One of the severe limitations is the lack of centralized procedures and standards in forensic laboratories. A majority of state-owned labs function on various protocols without the follow-up of a centralized accreditation or guidelines. Laboratories are to be certified by the Bureau of Indian Standards (BIS) and the National Accreditation Board for Testing and Calibration Laboratories (NABL), but not all forensic laboratories are accredited. This disparity has an impact on the consistency of results as well as their reliability in court. Additionally, judicial officials and investigating officers usually lack specialized expertise to collect, preserve, and interpret forensic evidence in a proper manner. Subsections like 53 BNSS and 184 BNSS provide for medical examination of victims and collection of biological samples but inadequate handling during the initial process makes forensic results useless or ineffective during court proceedings.

6.2. Accuracy and Reliability Issues

The credibility of forensic evidence is necessary for its admissibility in accordance with Section 39 of the Bharatiya Sakshya Adhiniyam, 2023. Nevertheless, the use of outdated technology, lack of proper validation of methods, and failure to meet scientific standards tends to result in dubious results. Failure to conduct peer review, calibration procedures, and disclosure of error rates also reduces accuracy. In the absence of institutionalized quality assurance procedures, forensic findings are susceptible to legal challenge and rejection.

6.3. Forensic Science Infrastructure in India

India's forensic facilities are grossly underdeveloped. Although Central and State Forensic Science Laboratories exist, advanced equipment, current databases, and personnel are unevenly available and lacking. The load on a few labs causes delays, case backlog, and in some cases, loss of crucial evidence integrity because of delays. Forensic sections such as DNA profiling or cyber forensics are still woefully under-equipped compared to demand.

Aspect	**Current Status**
Number of FSLs	~30+ state and regional labs; unevenly distributed
DNA Testing Facilities	Available in few central labs; limited in states

Accreditation (NABL/BIS)	Not mandatory; partial compliance among labs
Manpower	Shortage of qualified forensic scientists and lab technicians
Equipment Modernization	Outdated instruments in many regional labs

6.4. Legal and Ethical Issues

Legal protections of the forensic process are sporadic and not uniformly exercised. While the provisions of Sections 39 through 51 of the Bharatiya Sakshya Adhiniyam describe the service of expert evidence, no requirement is statutorily provided under which forensic bodies are independent from law enforcement administrations. This limited autonomy may subject forensic results to bias or coercion. In addition, the gathering and interpreting of DNA or electronic evidence pose privacy and consent issues, particularly with the lack of an overarching Data Protection Act or standard DNA profiling statute (proposed legislation as of recent versions).

6.5. Administrative and Budgetary Challenges

One of the major structural issues is the poor distribution of financial and administrative resources. The majority of forensic science laboratories are affiliated with state home departments and are subject to bureaucratic constraints, impacting hiring, procurement, and growth. Budgetary constraints lead to limited research, few training programs, and the inability to modernize existing systems. Even programs under the Ministry of Home Affairs, such as the Modernisation of Police Forces (MPF), have not seen substantial forensic infrastructure development at the grassroots level.

7. CASE LAWS

The increasing significance of forensic science in the Indian justice system has been heavily influenced by a sequence of milestone decisions that reflect its irreplaceable contribution to criminal investigations and delivery of justice. One of the most impressive cases in this respect is State of U.P. v. Ram Babu Mishra[20], in which the Supreme Court of India reiterated the pivotal role of forensic science in criminal trials. The Court emphasized that lack of negligence in performing due forensic examination could compromise the fate of a case. This judgment

[20] State of U.P. v. Ram Babu Mishra, A.I.R. 1980 S.C. 791

set the tone for the judiciary's practice based on forensic techniques to achieve precision and avoid miscarriages of justice.

Another landmark step in the development of forensic jurisprudence was M.S.K. Jha v. State of Bihar[21], which put DNA profiling in the center of Indian criminal investigations. The Supreme Court accepted DNA testing as a sure and necessary means to establish identities, which further set the stage for the general acceptability of DNA evidence in Indian courts. The judgment provided new opportunities for the use of high-tech forensic science in complicated criminal cases.

In K. K. Varma v. State of U.P. (1988), the courts upheld the employability of ballistic evidence to find a link between the suspect and the murder weapon. The case reasserted the reliability of forensic ballistics in criminal probes, further boosting the position of scientific evidence towards justice. In the same line, in State of U.P. v. Rajesh Gautam[22], the Supreme Court emphasized the need to adhere to strict procedures in the collection and examination of forensic evidence. It underlined that while forensic evidence is important, it has to be supported by other types of evidence to deliver a fair and just judgment.

A classic example of the application of forensic science in a high-profile case is the Nirbhaya case (Mukesh & Anr. v. State for NCT of Delhi[23]). In this case, DNA testing was instrumental in connecting the accused to the crime scene. Forensic scientists compared body fluid samples from the victim to the accused's DNA, which served as definitive evidence that was instrumental in the conviction. The case illustrated how sophisticated forensic techniques could aid justice in even the most intricate and emotionally charged cases.

In State of Karnataka v. S. Suresh[24], the Supreme Court relied on forensic examination of blood and hair samples recovered from the crime scene as key evidence to locate the accused at the crime scene. Application of such scientific methods facilitated the reconstruction of events, supported the case of the prosecution, and proved the involvement of the accused, thus establishing the probative value of forensic evidence.

In the same manner, in State of Maharashtra v. Sukh Ram[25], forensic science was utilized in tracing the moves of a serial offender. Forensic patterns across different crime sites were

[21] M.S.K. Jha v. State of Bihar, A.I.R. 1999 S.C. 1257
[22] State of U.P. v. Rajesh Gautam, A.I.R. 1991 S.C. 420
[23] Mukesh & Anr. v. State for NCT of Delhi, (2017) 6 S.C.C. 1
[24] State of Karnataka v. S. Suresh, A.I.R. 2013 S.C. 2148
[25] State of Maharashtra v. Sukh Ram, A.I.R. 1992 S.C. 1356

examined to determine a repetitive modus operandi, upon which several offences were traced back to one accused by the court. The case demonstrated the application of forensic methods not only to individual instances but to determining serial criminality within multiple jurisdictions.

In another pivotal case, Shivraj Patil v. State of Maharashtra[26], ballistic matching methods were employed by the forensic experts to establish the firearm used in a sequence of murders. Proper firearm identification served as definitive proof linking the accused to the offense. The case has set the example of how forensic science labs can disassemble fictitious stories and put together the true timeline through scientific accuracy.

8. COMPARATIVE ANALYSIS

Forensic science is of vital importance in criminal investigations globally, and its use differs from country to country. This comparative study identifies the contrasts and parallels between forensic practices in India, the USA, and the UK, with regard to infrastructure, legal systems, and overall effectiveness in criminal justice systems. Though India has achieved great progress in incorporating forensic science into its justice system, the USA and UK are usually considered to be ahead of the rest because of their superior technologies, established legal systems, and better forensic policies.

8.1. *Forensic Practices in India Compared to Other Nations (e.g., USA, UK)*

Forensic Practices in India

In India, forensic science is regulated by laws such as the Bharatiya Sakshya Adhiniyam, 2023 and the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023. The use of forensic science in criminal investigations primarily depends on the forensic labs in various states, which are run by respective state police forces or home ministries. Still, India continues to be plagued by many issues, such as poor infrastructure, absence of centralized standards, and delays in forensic analysis, which affect the overall efficiency of forensic science within the criminal justice system. In the context of particular forensic methods, India has made advancements in areas like DNA profiling and digital forensics, but resources for large-scale application of advanced techniques continue to be limited. The National Forensic Sciences University (NFSU) has come to be a prominent institution for training forensic experts, but there is a need for more regular training

[26] Shivraj Patil v. State of Maharashtra, A.I.R. 2017 S.C. 981

programs at the state and district levels. Additionally, lack of accreditation of majority of the forensic laboratories and lack of legal standards for forensic evidence handling weaken the reliability of forensic results in courts.

Forensic Practices in the USA

The United States possesses an adequately developed forensic science infrastructure at the federal and state levels, which is backed by several agencies. The Federal Bureau of Investigation (FBI), Department of Justice, and National Institute of Standards and Technology (NIST) are prominent institutions responsible for developing forensic science in the United States. Legal requirements like the Frye Standard and Daubert Standard in the USA regulate the admissibility of forensic evidence. These guidelines provide explicit criteria for identifying the scientific validity of forensic techniques prior to utilizing them in court. This guarantees that only certified and standardized forensic methods are applied, which minimizes the risk of errors or problems in court. In the USA, techniques such as DNA profiling, ballistics, and digital forensics are commonly used, backed by up-to-date technologies and adequately funded laboratories. The National DNA Index System (NDIS) and large DNA databases are keys to case solution, thus making forensic science a better tool in criminal investigations. The forensic infrastructure of the nation is also advantaged through the use of private sector laboratories and research centers, which offer additional resources and human capacity.[27]

Forensic Practices in the UK

The UK has a very centralized and structured forensic science system with considerable coordination between forensic service providers and law enforcement agencies. The Forensic Science Service (FSS), which was a government-owned enterprise, played a central role in forensic operations until it was closed in 2012. Forensic services have been outsourced to private enterprises ever since under strict regulation by the government. The law of the UK, represented by the Police and Criminal Evidence Act, 1984 and the Criminal Justice Act, 2003, supplies the law relating to the handling and utilization of forensic evidence for investigations and courtroom proceedings. UK forensic practices find support through superior forensic technology with a specific focus on DNA profiling, fingerprint comparison, and cyber forensics. The National DNA Database (NDNAD) is a critical weapon in the

[27] "Science and Technology," Federal Bureau of Investigation, 2022 *available at*: https://www.fbi.gov/how-we-investigate/science-and-technology (last visited June 5, 2025).

criminal justice system in the UK, enabling police to compare DNA evidence against a national database. This has greatly enhanced the rate of success of criminal investigations. Forensic crime scene protocols are also well established in the UK, as well as accreditation of forensic laboratories and training of forensic professionals.[28]

Key Differences in Forensic Practices

Aspect	**India**	**USA**	**UK**
Forensic Infrastructure	Limited facilities; uneven distribution across states	Well-funded and modernized facilities; national systems	Centralized, with a mix of government and private providers
Legal Framework	Governed by *Bharatiya Sakshya Adhiniyam* and *BNSS*	**Frye Standard** and **Daubert Standard** govern admissibility	Police and Criminal Evidence Act, 1984; Criminal Justice Act, 2003
Forensic Techniques	Growing emphasis on DNA and digital forensics; limited resources	Advanced techniques in DNA profiling, ballistics, and digital forensics	Leading in DNA profiling and digital forensics
Database Systems	Emerging DNA databases and national efforts (e.g., NFSU)	**National DNA Index System (NDIS)** and extensive databases	**National DNA Database (NDNAD)**
Training and Education	National Forensic Sciences University (NFSU)	Extensive training through	Comprehensive training programs and

[28] Emmanuel Nsiah Amoako and Carole Mccartney, "The UK forensic science regulator: Fit for purpose?" Wiley, 2021 *available at*: https://www.researchgate.net/publication/349627547_The_UK_forensic_science_regulator_Fit_for_purpose (last visited June 5, 2025).

	emerging; limited widespread training	agencies like the FBI, NIST	professional standards

While India has made notable strides in integrating forensic science into its criminal justice system, it lags behind countries like the USA and the UK in several key aspects. The USA benefits from a well-funded and centralized forensic infrastructure, supported by strict legal standards for the admissibility of forensic evidence. The UK, with its highly organized and regulated forensic practices, has created a system where forensic evidence is efficiently integrated into criminal investigations.

9. CONCLUSION

The contribution of forensic science to criminal investigations in India is essential but beset by many challenges that affect its efficiency in the justice system. The legal environment governing forensic evidence, specifically the Bharatiya Sakshya Adhiniyam, 2023 and the Bharatiya Nagarik Suraksha Sanhita, 2023, offers a framework for its utilization and admissibility in court. Nonetheless, the use of forensic science in this system is frequently marred by the absence of standardization, slow processes, and variable infrastructure nationwide. Although the Bharatiya Sakshya Adhiniyam clearly stipulates provisions for the submission of expert testimony, such as forensic evidence, these provisions are not always adequately enforced, and consequently, untrustworthy or mishandled forensic evidence ends up in courts.

Forensic science methods like DNA testing, ballistics, toxicology, and computer forensics are widely accepted to be important tools in criminal investigations. But their real-world application throughout India is uneven. While some states possess modern forensic laboratories with latest technologies, others are plagued by outdated facilities and inadequate trained staff. The National Forensic Sciences University (NFSU) has come a long way in educating forensic professionals, but theoretical education still lags far behind practical field needs. Forensic laboratories also tend to experience delays in evidence processing, which fuels case backlogs and erodes the prompt dispensation of justice. These delays lead to loss of faith in the role played by forensic science in the judicial process, particularly in high-profile criminal proceedings.

The country's institutional framework for forensic science still encounters a number of operation issues such as a lack of proper funding, archaic apparatus, and a lack of well-trained experts. The majority of forensic science laboratories are under state

control, causing uneven allocation of resources and discrepancies in their efficiency levels. The absence of nationwide uniformity in standards and regulatory practices exacerbates the quality of forensic analysis. Although centralized initiatives like the Bureau of Police Research and Development (BPRD) and the modernization programs of the Ministry of Home Affairs seek to enhance forensic strengths, the outcome has remained sluggish, particularly in rural or less-developed regions.

Court trends show an increasingly common acknowledgment of forensic evidence but complexities in its acceptance in court. Even with explicit legal standards for the admissibility of expert testimony, courts frequently struggle in assessing the scientific credibility of forensic evidence. Lack of clear guidelines on the qualification of forensic experts, inconsistent application of the standards on forensic evidence, and inadequate judicial appreciation of sophisticated forensic techniques are among the reasons for the unwelcome integration of forensic science within the legal process. Courts have in some instances rejected forensic evidence on account of questioning its accuracy, especially concerning handling physical evidence or expert testimony credibility.

In order to maximize the utility and transparency of forensic science in India, there are a number of reforms that must be implemented. Formalization of the legal process governing forensic evidence, such as more specific requirements for the accreditation of forensic labs, would make results more consistent and reliable. Moreover, encouraging greater centralization and standardization of training for law enforcement and judicial officers would improve forensic evidence handling at every level of the justice system. Additionally, sufficient funding and infrastructure facilitation of forensic labs, especially in disadvantaged areas, are imperative in filling the gap between forensic science potential and current shortcomings. Last but not least, increased effort towards fusion of interdisciplinary perspectives within the legal process, in which judges and lawyers are offered periodic training in developments in forensic science, will promote the credibility and admissibility of forensic evidence in court.

10. RECOMMENDATIONS FOR STRENGTHENING FORENSIC SCIENCE IN CRIMINAL INVESTIGATIONS

To fortify forensic science for criminal investigations in India, the following major suggestions can be offered. Firstly, forensic infrastructure has to be upgraded. Modern forensic laboratories have to be developed at the national level, particularly in rural and less developed regions, to provide consistent access to high-

quality forensic services. This would necessitate additional investment by the state as well as the central government in order to develop and upgrade laboratories and procure cutting-edge forensic machinery.

Second, standardization and accreditation of forensic practice are required. The National Accreditation Board for Testing and Calibration Laboratories (NABL) and the Bureau of Indian Standards (BIS) must take a more proactive role in ensuring that all forensic science laboratories are standardized and accredited. A single set of guidelines for collection, handling, and analysis of evidence should be implemented throughout all states to avoid discrepancies and improve the credibility of forensic findings.

Third, training and capacity-building courses must be increased for law enforcement officers, forensic scientists, and judicial officers. Periodic workshops, training modules, and coordination with international forensic centers can enhance the knowledge and skills of all staff engaged in forensic investigations. Moreover, educational programs at the National Forensic Sciences University (NFSU) must be increased to provide a continuous supply of qualified professionals.

Fourth, legal changes are required to improve the admissibility and credibility of forensic evidence. Definite rules must be framed for the qualification and appointment of forensic experts, and greater prominence must be accorded to forensic evidence during court hearings. Legal provisions must also be revised to tackle new challenges in fields such as digital forensics and privacy concerns.

Finally, public-private partnerships can be leveraged to promote innovation, resource sharing, and the emulation of best practices in forensic science.

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