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INTEGRATING FORENSIC EVIDENCE AND TECHNOLOGY IN INDIA: CHALLENGES AND WAY FORWARD

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I. Introduction

A crime scene is not merely a spot where something unfortunate took place. Besides that, it is also a complete story waiting to be told. Every small detail which otherwise may not draw attention is a crucial clue in order to unravel the mystery of how the crime was committed. These clues and small details are pathways, ultimately leading to the perpetrator. Forensic science is the art of studying these small details and clues in order to get insights into the crime that was committed. The tools which are relied upon in this art are the forensic evidence and technology. India's criminal justice system, as like many other countries, has evolved from relying on rudimentary elements to going on to include well developed systems of forensic evidence collection in order to decipher these stories. Moving on from reliance on British enacted laws and codes such as the Indian Evidence Act, 1872, Code of Criminal Procedure, 1973 and Indian Penal Code, 1860 to recent enactments such as the Bhartiya Sakshya Adhiniyam, 2023, Bharatiya Nagarik Suraksha Sanhita (BNSS) 2023, and Bhartiya Nyaya Sanhita 2023 which replaced them on July 1, 2024 we have come a long way. These laws have tried to improve the existing framework so as to consolidate the forensic evidence collection and provide for an efficient justice delivery system. In spite of this major overhaul, the forensic evidence collection and technology in India is marred by a plethora of issues and lacunae. These issues pose a formidable challenge to harnessing the true potential of forensic science in India.

This article provides insights into the evolution of forensic evidence collection in India, the legal framework associated with it, the landmark case laws which have strengthened this framework, the major challenges which pose as a hindrance and suggestions for weeding out these issues so as to establish a better criminal investigation system in order to ensure fair and manifest justice delivery.

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II. Meaning, significance and scope of Forensic Evidence and Technology in Criminal Justice

The term Forensic Evidence refers to information, material or data obtained through scientific methods and used in courts of law for the purpose of establishing facts in criminal or civil investigations. On the other hand, Forensic technology denotes the array of scientific tools and procedures used to analyse evidence within investigative and judicial contexts. It encompasses DNA profiling, fingerprints, ballistics, digital/electronic data, toxicology, and other scientific analyses. According to *Black's Law Dictionary*, forensic evidence is *"*Evidence that can be used in a court based on science. It can be blood tests, ballistics, and DNA.*"*[3] *According to Professor Erin Murphy*, Forensic Evidence means "evidence derived from the use of a field of science or the scientific method in order to investigate and prove crimes. Accordingly, the phrase encompasses a broad range of disciplines, ranging from "softer" fields of study like psychology or social science to "harder" methods such as biology or chemistry. "Forensic evidence" thus includes everything from a DNA match to a mental-illness diagnosis to the results of a study that reveals cognitive biases in eyewitness identification." [4] The Indian legal system does not provide a codified definition of forensic evidence, but the **Indian Evidence Act, 1872** (now Bharatiya Sakshya Adhiniyam, 2023) recognised the relevance of expert opinion under Sections 45 and 45A, (Corresponding to Section 39(1) and Section 39(2) of the Bharatiya Sakshya Adhiniyam, 2023[5]) which permit courts to rely on experts in science, handwriting, fingerprinting, or electronic evidence. With the enactment of the Bhartiya Sakshya Adhiniyam, 2023, the scope of the field of expert opinion has been broadened by incorporation of the phrase "or any other field" under Section 39(1), in addition to preexisting domains, which indicates an acknowledgement of novel fields wherein an expert opinion might come handy with the onset of ever evolving science and technology as well as transforming society.

The significance of the Forensic Evidence and Technology in Criminal Justice can be broadly viewed under the following three heads:

(i) **Accuracy in Investigation**: It ensures precision in linking suspects to crime scenes, thus minimising wrongful implication or acquittal. For example, DNA profiling has

[3] *The Law Dictionary, available at:* https://thelawdictionary.org/forensic-evidence/ (last visited on 21.10.2025)
[4] Erin Murphy, "Forensic Evidence" 3 *Reforming Criminal Justice* 171 (2017)
[5] Bhartiya Sakshya Adhiniyam, 2023 (Act 47 of 2023) Section 39

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played a pivotal role in securing convictions as well as overturning wrongful prosecutions, as shown by several cases of exoneration.[6]

(ii) **Judicial Confidence**: Courts have routinely encouraged a marked emphasis on scientific evidence over merely relying on confessions or witness statements. The honourable Supreme Court of India in the matter of *Ritesh Sinha v. State of Uttar Pradesh* (2019)[7] highlighted the importance of scientific tools and methods in criminal investigations, especially in verifying truth without infringing upon constitutionally mandated rights.

(iii) **Policy and Reform Impact**: Low conviction rates in India (around 33% according to NCRB data)[8] have pushed policymakers to focus on forensic science as a means to strengthen investigative credibility. The BNSS, 2023 reflects this emphasis by mandating forensic examination in serious offences.

As far as the scope of the Forensic Evidence and Technology in Criminal Justice is concerned, it can be safely presumed that in this case sky is the limit. Forensic Evidence and Technology as a tool are expansive and constantly evolving. DNA profiling is now recognised as the "gold standard" for identity verification, and India attempted to introduce a comprehensive DNA Technology (Use and Application) Regulation Bill, 2019. This bill was later withdrawn in July, 2023[9] because its core provisions were covered by the subsequent Criminal Procedure (Identification) Act, 2022[10]. Artificial intelligence (AI) tools for predictive policing, automated facial recognition systems (as piloted by some state police units), and blockchain for chain-of-custody records represent the expanding frontier of forensic application. International practices, such as the US *Daubert* standard[11] for scientific reliability and the UK's Forensic Science Regulator model, highlight the growing scope of institutionalising forensic reliability.

III. Historical and gradual evolution of Forensic Evidence and Technology in India

In ancient India (up to the pre-colonial period), the principles of evidence collection and examination can still be found. Although these principles and methods may seem to be

[6] Innocence Project, "DNA Exonerations in the United States" (2022), *available at*: https://innocenceproject.org/ (last visited on 21.10.2025)
[7] (2019) 8 SCC 1
[8] National Crime Records Bureau, "Crime in India, Volume III, 1260" (Ministry of Home Affairs, 2022)
[9]The DNA Technology (Use and Application) Regulation Bill, 2019, Ministry of Science and Technology and Earth Sciences
[10] The Criminal Procedure (Identification) Act, 2022 (Act 11 of 2022)
[11] *Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993)

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rudimentary in comparison to modern scientific advancements. Kautilya's *Arthashastra*, written more than two thousand years ago, offers strikingly detailed guidance on investigation and proof. It discusses the role of witnesses, interrogation, and the use of whatever scientific reasoning was available at the time. Local customs and community justice systems of the time primarily relied on observation and oral testimonies This irrefutably proves that the idea of gathering and evaluating evidence is not a modern import into Indian law and that the search for truth and systematic enquiry has deep roots in India's own legal tradition.

Moving ahead, during the British colonial period (19th – early 20th Century), modern methods of criminal investigation and evidence collection were introduced encompassing systematic processes in criminal investigation and scientific tools. In 1897, with the establishment of the Fingerprint Bureau in Calcutta (now Kolkata) by Sir Edward Henry, Inspector General of Police, India became one of the first countries to introduce fingerprinting in criminal investigations. By the end of the 19th Century and early 20th Century, developments in forensic medicine and toxicology saw a rise in India. Technological progress in the field of toxicology was catalysed by a prevalence of poison-related deaths in India. As far as institutional framework is concerned, the establishment of the Criminal Investigation Department by the British laid down the foundation for formal criminal investigations[12].

Post-Independence (1947-1950s), India embarked on a journey of an independent legal framework with the adoption of the Indian Penal Code (IPC) in 1860, the Indian Evidence Act in 1872, and the Criminal Procedure Code (CrPC) in 1973 along with necessary amendments. This set the stage for integrating forensic science within the framework of legal proceedings. With the establishment of the Central Forensic Science Laboratory (CFSL) in 1957[13], law enforcement in India gained institutional access to scientific methods of evidence analysis. Between 1960s to 1970s a slew of advancements was made in this field. Establishment of regional forensic laboratories, integration of forensic disciplines such as serology, ballistics and toxicology into criminal investigations and some advancements in to biochemical analysis enabled the law enforcement agencies to approach the evidence collection and draw conclusions thereby with a more scientific and modern approach. In 1980s-1990s the invention of DNA profiling proved to be revolutionary in the domain of criminal investigation. The

[12] Praveen Singh Chauhan and Vaishali Patel "A comprehensive study of forensic science in the Indian legal context: Challenges, opportunities, and implications for criminal investigations and trials" 4(2) *IJLJJ* 307 (2024)
[13] Ministry of Home Affairs, DFSS Brochure 2023

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credibility of forensic science gained widespread acceptance, specifically in criminal trials wherein forensic experts testified on matters that required special knowledge.

The recent years (2000s-present) have been the years of scientific advancement and cutting-edge technological innovation. The field of Forensic Evidence and technology also has not remained untouched by this progress. The advent of 21st century has seen the evolution of advanced forensic technology such as forensic anthropology, forensic odontology, and digital forensic. Digital forensics has become ever more important so as to deal with the rising and consistently transforming nature of cybercrimes. The Forensic Sciences University established in 2008 in Gandhinagar, Gujarat, has proved to be a milestone in institutionalizing the dissemination of specialized education and research in forensic science giving a major fillip to professional training and knowledge in this field.

IV. Statutory and Judicial Development of Forensic Evidence in India

In India, the shift towards forensic science and the reliance on forensic evidence has been gradual. The integration of forensic science and technology into Indian legal system began with the introduction of following three penal laws which proved to be the cornerstone of India's legal and juristic framework viz. The Indian Penal Code, 1860, The Indian Evidence Act, 1872 and the Code of Criminal Procedure, 1973.

The Indian Penal Code (1860) does not expressly define forensic evidence but it relies on several forms of forensic evidence in order to serve as a tool for investigation of a crime. Forensic methods such as DNA profiling, ballistic analysis, and toxicology are crucial in cases of murder (Section 302) and sexual offenses (Section 376)[14]. In cases of Culpable Homicide under Section 304[15] forensic evidence such as post-mortem reports and autopsy results helps determine the cause of death and the manner in which it occurred. Section 326 of the Indian Penal Code which provides for voluntarily causing grievous hurt by dangerous weapons or means and Section 328 which provides for causing hurt by poison, etc.[16] made it necessary to test chemically and biologically in order to establish the nature and impact of the object or substances used to cause such injury.

[14] The Indian Penal Code, 1860 (Act 45 of 1860), s.302, 376 and 328
[15] *Ibid* s.304
[16] *Ibid* s.326 and 328

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The Indian Penal Code also anticipates the need for forensic analysis in offences like forgery and counterfeiting (Sections 463–489), where analysis of handwriting, digital forensics, and documentary examination have become indispensable in proving criminal intent and material falsification. In cases pertaining to sexual offence under Sections 375 and 376[17], medical and DNA evidence play a pivotal role in corroborating the victim's testimony. The drafters of these laws might not have foreseen modern technological advancements such as DNA profiling or cyber-forensics, but the overall phrasing of many provisions allows the present courts to interpret as well as apply scientific evidence within the existing framework even if express mention of such evidence is missing. Hence, even though the IPC does not explicitly mention forensic science, its application in practice shows that forensic evidence is intertwined into the very fabric of criminal justice under this Code.

The Indian Evidence Act of 1872 formed the very basis of evidentiary law in India for years. It played a pivotal role in providing legal backbone and structure to the use of forensic evidence in judicial proceedings in India. Although this Act was enacted in an era which preceded modern forensic advancement, its provisions were flexible and capable enough of accommodating the evolving scientific methods. Section 45[18] of this act was the most pertinent acknowledgment of upholding the importance of expert and scientific testimony. It stated that opinions of persons specially skilled in foreign law, science, art, handwriting, or finger impressions was relevant when the court had to form an opinion with respect to such matters. This provision served as the legal foundation for the admissibility of opinion of forensic experts in the fields of medicine, ballistics, toxicology, DNA profiling, fingerprint matching, and handwriting analysis[19]. Furthermore, Section 46 allowed facts that support or contradict an expert's opinion to be considered relevant. This ensured a balanced approach to the provisions of scientific evidence. The Act also addressed the subject of documentary and electronic evidence under Sections 61 to 65B[20]. This has gained prominence in the modern digital age. The Supreme Court in the matter of *Anvar P.V. v. P.K. Basheer* (2014)[21] clarified that electronic records must comply with the requirements of Section 65B in order to be admissible, reinforcing its importance in handling digital forensics. Earlier, in the matter of *State of H.P.*

[17] *Ibid* s. 375 and 376
[18] The Indian Evidence Act, 1872 (Act 1 of 1872), s.45
[19] Kunal Kanwat, "The Role of Forensic Evidence in Criminal Investigations in India" 12(3) *IJCRT* a118 (2024)
[20] The Indian Evidence Act, 1872 (Act 1 of 1872), s.61 – 65B
[21] (2014) 10 SCC 473

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v. Jai Lal (1999)[22], the Hon'ble Apex Court held that the evidence of scientific opinion, if intelligible, trustworthy and reliable, becomes an important factor for consideration in a matter along with the other evidence of the case.

The Criminal Procedure Code (CrPC) of 1973 mandated the process by which forensic evidence is to operate in the judicial system, laying down the procedures for investigation, collection, examination, and presentation of evidence before courts. Though the Code did not use the term "forensic," its sections impliedly facilitated scientific investigation. Sections 53 and 54[23] of the code authorized medical examination of the accused and victims in specific circumstances. They allowed for the collection of biological samples such as blood, semen, and hair. These procedures now form the basis of DNA profiling and other modern forensic techniques. Section 164 empowered magistrates to record confessions and statements that may have relied on technological aid. Sections 291 and 293[24] recognized expert reports from government scientific experts, including those from forensic science laboratories. The inclusion of these provisions indicated a legislative foresight in integrating forensic and scientific expertise into the criminal justice process.

In the course of time and history, various landmark judicial decisions have strengthened the framework of forensic evidence collection and its abject importance by giving a gradual regard and recognition to forensic tools and their irrefutable importance in criminal investigation. In the matter of *State of Bombay v. Kathi Kalu Oghad* (1961)[25] the central issue of law was whether obtaining a person's handwriting, signature, thumb impressions, or specimen during investigation amounts to "testimonial compulsion" and therefore violates Article 20(3) of the Constitution? The Supreme Court clarified that compelling an accused to provide fingerprints or handwriting samples does not violate Article 20(3) of the Constitution, since these do not amount to testimonial compulsion. This case laid the constitutional foundation for modern forensic practices in India, as it clarified that scientific methods of evidence collection do not violate fundamental rights under Article 20(3)[26]. It gave legitimacy to forensic science as an investigative tool and ensured that technological procedures for collecting physical evidence could be used without infringing self-incrimination protections. In *Nandini Satpathy v. P.L.*

[22] (1999) 7 SCC 280
[23] The Criminal Procedure Code, 1973 (Act 2 of 1974) s. 53 and 54
[24] *Supra* note 23 s.164, 291 and 293
[25] (1962) 3 SCR 10
[26] The Constitution of India, art. 20

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Dani (1978)[27] the question of law that was analysed by the Supreme Court was whether the protection under Article 20(3) of the Constitution that is "No person accused of any offence shall be compelled to be a witness against himself', extends to the stage of police investigation? The Hon'ble apex court held that the right under Article 20(3) applies not merely during trial but also during the stage of investigation, protecting an accused from any compelled testimony that could be self-incriminatory. The *Nandini Satpathy* judgment established a critical boundary between lawful scientific evidence collection and unconstitutional testimonial compulsion. It enshrined the principle that scientific evidence collection must balance investigative efficiency with human rights safeguards, setting the constitutional tone for India's forensic framework.

In the matter of *State of Himachal Pradesh v. Jai Lal & Ors*. (1999)[28] the Hon'ble Supreme Court of India tried to answer as to what was the evidentiary value of an expert's opinion in a criminal trial? The court held in this matter that expert evidence is advisory and not substantive. It further clarified that such evidence must be based on reliable and scientific methods, and unambiguously explained so that the court can examine its validity. The Apex court further laid down that only those persons with recognized and specialized knowledge, obtained through formal study, research, or significant experience, would meet the criteria for being treated as an expert for all evidentiary purposes. This landmark case set out the essential principles for the application and limitations of forensic science in India's justice delivery system. In *Sharda v. Dharmpal* (2003)[29] the Supreme Court of India delved into the issue whether ordering a medical examination is violative of the right to privacy guaranteed under Article 21 of the Constitution of India? The court held that the order for medical examination was not a violation of Article 21, if done judiciously within the legal safeguards. The court emphasized on the fact that right to privacy can be curtailed in the interest of justice but only to that extent which is necessary. The Court further stated that the medical evidence including psychiatric examination is relevant and at times essential in matrimonial litigation in order to examine allegations of mental illness. This case proved to be pivotal in affirming the judicial backing for the use of medical and forensic examinations in not only criminal cases but also in civil cases, such as matrimonial disputes. In the landmark judgment of *Selvi & Ors. v. State of Karnataka* (2010)[30] the apex court analysed the core issues pertaining

[27] (1978) 2 SCC 424
[28] *Supra* note 22
[29] AIR 2003 SC 63
[30] AIR 2010 SC 1974

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to forensic evidence. In this case it was debated if narco-analysis, polygraph tests, and brain mapping are valid methods of extracting evidence under Indian laws? The Supreme Court held that the use of narco-analysis, polygraph tests, and brain mapping without the consent of the accused violates their constitutional rights under Articles 20(3) and 21. This landmark judgment established the crucial constitutional guidelines which regulate the modern forensic investigative technologies involving the mind and body. In the matter of *State of Uttar Pradesh v. Rajesh Gautam* (2003)[31] the Supreme Court stressed upon the importance of forensic evidence as a valuable tool in criminal investigations and conviction but emphasized that forensic evidence must be reliable and properly obtained. This case reiterated that forensic evidence is an essential and reliable component of modern criminal justice albeit it is properly and lawfully obtained and handled.

More recently, in the matter of *Nirbhaya Case (Mukesh & Anr. v. State of NCT of Delhi, 2017)*[32] the Apex court examined the role and admissibility of forensic evidence in criminal proceedings. It tried to answer the question that can forensic evidence, including DNA analysis and ballistic reports, form the sole basis for conviction? The court while upholding the convictions of the accused held that DNA profiling was a scientifically reliable and admissible evidence but it is conditioned upon the fact that in case of such evidence the laboratory must follow accredited and recognized procedures. In this case the ballistic evidence helped in connecting the accused to the crime. This judgment reaffirmed that forensic technology and scientific evidence significantly strengthen the criminal justice process by adding an objective and empirical proof so as to decide the liability justifiably.

Further, in *Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal & Ors.* (2020)[33] the Supreme Court reiterated that forensic evidence, including expert examination of documents, signatures, and handwriting, is admissible and valuable when they are collected and examined while following recognized scientific standards. This judgment was pivotal in upholding the judicial acceptance of forensic document examination as dependable evidence in criminal prosecution, particularly in case of economic offences and corruption cases. In *Amlesh Kumar v. State of Bihar* (2025)[34] the issue was whether a forced narco-analysis test violates the constitutional rights of the accused, particularly under Articles 20(3) and 21? The court in this

[31]AIR 2003 SC 1908
[32]AIR 2017 SC 1369
[33]AIR 2020 SC 302
[34] 2025 INSC 810

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matter reiterated the precedent set in Selvi & Ors. v. State of Karnataka (2010), holding that forced narco-analysis or similar scientific tests strike at the very roots of Article 20(3) and Article 21. This judgment is a landmark ruling wherein it was held that scientific forensic tests cannot override constitutional rights. It outlines the limits of forensic technologies involving mental or bodily intrusion, such as narco-analysis, lie detector (polygraph) tests, and brain mapping.

A vivid study of the abovementioned case laws clearly establish that the Supreme Court of India has, from time to time, filled in the gaps and lacunae present in the statutory provisions pertaining to forensic evidence collection, their application and their evidentiary value. The court has been a catalyst in further development and evolution of forensic evidence and technology in India.

V. The enactment of BNSS 2023 and BSA 2023 and the forensic provisions under them:

The preexisting legal framework comprising of the Code of Criminal Procedure, 1973 (CrPC), Indian Evidence act and the Indian Penal Code provided limited scope for mandatory forensic intervention. Persistent issues of wrongful acquittals, long delays in investigation, and low conviction rates, specifically with respect to crimes against women (State-UT wise) hovering around 25.3% in recent years according to National Crime Records Bureau data[35], highlighted the need for statutory reforms.

The enactment of the Bharatiya Nagarik Suraksha Sanhita (BNSS) 2023, replacing the CrPC, Bhartiya Sakshya Adhiniyam replacing the Indian Evidence Act and Bhartiya Nyaya Sanhita replacing the Indian Penal Code, points towards a legislative intent to harness the complete potential of forensic science as far as criminal procedure and investigation are concerned. Provisions of these new laws such as mandatory forensic involvement in grave offences, compulsory videography of searches, and recognition of electronic evidence demonstrate this intent. Such novel reforms seek to structurally integrate science and technology into law enforcement, evidence gathering, and judicial deliberation. The ultimate aim of such welcome changes is to herald a new era of scientific criminal jurisprudence based on sound technology. While this introduction is praiseworthy yet, the adoption of forensic technology brings its own

[35] National Crime Records Bureau, "Crime in India Statistics", Volume I, 253 (Ministry of Home Affairs, 2022)

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set of challenges such as legal, institutional, technical, ethical questions, infrastructural bottlenecks, procedural uncertainties, questions of admissibility, and concerns about human rights which demand a thorough examination.

The BNSS, alongside the Bharatiya Nyaya Sanhita (BNS) 2023 and Bharatiya Sakshya Adhiniyam (BSA) 2023, form the cornerstone of India's criminal justice framework overhaul. It targets slow paced investigations, criminally low conviction rates, and rising public distrust. Its provisions on forensics and technology are a major leap toward a system where a DNA match or a time stamped video can aid immensely in deciding the case in the interest of justice. The BNSS enacts several crucial provisions that transform forensic science from being merely supportive to a central to the investigation.

a. Section 176(3): This Section of the BNSS provides for mandatory forensic involvement.

   According to this section, in all offences punishable with imprisonment of seven years or more, the investigating officer must seek assistance from forensic experts.[36] This provision reflects legislative recognition of the fact that serious crimes demand sound scientific corroboration which is beyond mere conventional witness testimony.

b. Section 105: This Section provides for Videography of Searches and Seizures. To promote transparency and prevent allegations of fabrication, the BNSS obligates videography of search and seizure operations.[37] The digital record ensures better chain of custody and strengthens the probative value of evidence.

c. Section 185: This Section provides for Electronic Communications. The BNSS recognises the increasing role of electronic communications in crime, including emails, instant messaging, and digital platforms. Investigative powers extend to preserving and producing such data.[38]

d. Section 329: Allows a report from a government or any other scientific expert (appointed by Central or State Government) to be submitted without oral testimony, increasing efficiency and modernization of expert evidence use in courts.[39]

e. Section 349: Expands Magistrate's power to order collection of forensic samples, including fingerprints, voice samples, handwriting, and signatures from any person via

[36] Bharatiya Nagarik Suraksha Sanhita, 2023 (Act No. 46 of 2023) s. 176(3)
[37] *Ibid*., s. 105
[38] Bharatiya Nagarik Suraksha Sanhita, 2023 (Act No. 46 of 2023) s. 185
[39] *Ibid*., s. 329

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written order. It is broader in scope than CrPC Section 311A as it allows sample collection even without prior arrest, thereby facilitating early forensic intervention[40].

f. Section 330: Introduces procedures requiring that all documents (including electronic/digital) filed in court be listed, and their genuineness be admitted or disputed by parties, enhancing handling of digital forensic evidence.[41]
g. Digital Evidence: BNSS expands the definition of "documents" and "evidence" to cover electronic records, including emails, server logs, cloud data, social media records, and other digital traces, aligned with modern forensic needs. This facilitates electronic appearance of witnesses and expert evidence through video conferencing, reducing delays and enabling remote forensic testimonies.

The Bharatiya Sakshya Adhiniyam, 2023 (BSA) also provides for several sections pertaining to forensic evidence in order to provide a solid legal basis for investigation in congruence with the provisions of BNSS, 2023. These provisions are enumerated herein below:

a. Section 39: This section enlarges the ambit of expert opinion by keeping the fields wherein expert opinion is required as mentioned in the Indian Evidence Act, 1872 but also includes "any other field" within its ambit in view of the present and future developments as well as changes in the field of science and technology and other walks of human life.
b. Section 61 to 63: These sections deal explicitly with electronic and digital evidence admissibility, certification, and authentication. It requires custodians and notified forensic experts to certify digital records for admissibility, reinforcing chain-of-custody controls in cyber forensic evidence. These sections introduce modern rules to handle new-age digital forensic evidence distinct from traditional documents.[42]
c. Expansion of Expert Witness Categories: BSA expands the definition of experts to include "or any field". As such this expansion would also include those skilled in digital forensics, network analysis, and other emerging technologies.
d. Procedural Innovation: The BSA provides for modern forensic methods like image and video evidence handling, electronic data recovery, and voice mail authentication. As such this would be pivotal in improving forensic scientific credibility.

[40] *Ibid*. s. 349
[41] *Ibid*. s. 330
[42] Bharatiya Sakshya Adhiniyam, 2023 (Act No. 47 of 2023) s.39 and 61-63

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Thus, BNSS and BSA provide a complete and comprehensive, technology-heavy overhaul of forensic evidence laws in India. The BNSS provides for forensic expert involvement in crime scenes for serious offences and wider magisterial powers for sampling of forensic evidence. BSA modernizes admissibility and certification of electronic evidence, strengthening chain of custody and expert evidence. These laws represent a significant leap from procedural ambiguities in CrPC and the Indian Evidence Act, responding dynamically to challenges posed by digital forensics to improve justice accuracy, speed, and reliability. Additionally, the enactment of the Criminal Procedure (Identification) Act, 2022 provides for a specific statute pertaining to collecting forensic evidence and investigation thereof in criminal matters. Section 2(b) of the act defines "measurements" to include finger-impressions, palm-print impressions, foot-print impressions, photographs, iris and retina scan, physical, biological samples and their analysis, behavioural attributes including signatures, handwriting or any other examination.[43] The inclusion of "biological samples" in this act gives a nod to collection of DNA samples for the purpose of criminal investigation and forensic analysis.

VI. Technological Integration in Criminal Justice

The impact of BNSS 2023 is not limited to traditional forensic sciences. It brings into focus newer domains of technology in criminal justice. We explore some of the cutting-edge forensic technology that are utilised across the country to collect forensic evidence and thus aid in investigations:

i. Narco Test: Narcoanalysis, commonly referred to as the "truth serum" test entails the utilization of specific drugs like sodium pentothal or sodium amytal to induce a state of reduced inhibition and heightened susceptibility to suggestion in an individual's consciousness[44]. In the infamous Godhara riots case of 2002, this technology was utilised to gain insights into the investigation.

ii. Lie detection: Lie detection is based on the principle of the human body displaying subtle yet visible signs of physical and psychological changes while a person is telling a lie. It is also known as Polygraph test. An accused while undergoing this test displays an elevated heart rate, blood pressure and adrenaline levels in blood stream when

[43] *Supra* note 10 Section 2(b)
[44] B Priyanka "Justice under the microscope: Forensic science in the Indian criminal justice system", 6(2), *IJLPS*, 82 (2024)

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subjected to questioning pertaining to the alleged crime or any criminal activity whatsoever.[45]

iii. DNA Profiling: DNA profiling is a very accurate method of forensic inquiry. When traditional procedures are ineffective for identifying suspects in crimes like murder, rape, and theft, DNA evidence has proved to be a valuable tool[46]. Blood, sperm, bone, saliva, and other bodily fluids and tissues may all be mined for DNA which is unique to a person and thus plays a pivotal role in finding out the culprit.

iv. Brain Mapping Test: It is a test designed to study the neural activity of a person while under interrogation. The brain function in terms of electric waves is recorded during the duration of the investigation.

v. Fingerprints: Every human person is born with a unique fingerprint, a series of ridges along each fingertip[47]. Due to the inherent nature of uniqueness, crime scene investigators have long relied on fingerprints as a crucial piece of evidence.

vi. Digital and Cyber Forensics: With cybercrime on the rise, digital forensics covering data recovery, metadata analysis, and encrypted communication has become central. For example, in cyber-fraud cases investigated by the police, forensic tools help trace IP addresses and reconstruct digital footprints. There has been a 24.4% rise in the registration of cybercrimes over 2021 in the year 2022[48].

vii. Artificial Intelligence Tools: Facial recognition systems, predictive policing models, and voice analytics are gradually being adopted. Telangana has already experimented with AI-based facial recognition in policing, which has sparked debate over privacy.[49]

VII. Persisting challenges with respect to optimal utilization of Forensic Evidence and Technology.

The foregoing paragraphs clearly establish the acute importance of Forensic evidence and technology as an irrefutable and indispensable tool to aid the justice delivery system in order to ensure a fair trial and deliver manifest and pervasive justice. But despite significant strides in the establishment of forensic laboratories and the introduction of modern investigative tools,

[45] *Ibid*, note 44
[46] *Supra* note 19
[47] Khin Nandar Win, "Fingerprint classification and identification algorithms for criminal investigation: A survey" 110 *Future Generation Computer Systems*, 758 (2020)
[48] NCRB "Crime in India statistics", Vol. 2 (Ministry of Home Affairs, 2022)
[49] Srinivasa Rao Apparasu, "Telangana's facial recognition technology comes under scanner" *Hindustan Times*, Jan 6, 2022, available at: https://www.hindustantimes.com/india-news/telanganas-facial-recognition-technology-comes-under-scanner-101641409527024.html (Last visited on 22-10-2025)

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India continues to struggle with the optimal and comprehensive integration of forensic technology within its criminal justice system. The existing infrastructure remains unevenly distributed, and the absence of trained personnel often results in sub-optimal use of available resources. As a consequence, the true potential of forensic science which is to bring objectivity, speed, and credibility to criminal investigation, remains only partially realized. These challenges can be broadly studied and examined under the following categories:

1. Legal Challenges:
    a. Admissibility Standards: Unlike the Daubert standard in the United States[50], Indian law lacks a clear test for scientific reliability. Courts often rely on precedent and discretion, which may lead to inconsistent outcomes.
    b. Constitutional Safeguards: The expansion of forensic methods risks infringing Article 20(3). Compulsory collection of biological samples or voice data may test the limits of the protection against self-incrimination.
    c. Privacy Concerns: With the Digital Personal Data Protection Act yet to be fully operationalised, the collection of DNA, biometric, and electronic data risks misuse.[51]
2. Technical Challenges:
    a. Forensic Infrastructure: India has approximately 30 state and central forensic laboratories, which are insufficient for the volume of cases. As of 2021, over 0.7 to 0.8 million cases were pending examination at Forensic Science Laboratories nationwide[52]. There is an uneven distribution and under-resourcing of forensic science laboratories (FSLs) across India. This includes both a shortage of modern equipment and insufficient maintenance, particularly acute in rural and semi-urban regions. Delays and quality variation hinder the reliability of forensic results.
    b. Delays and Inaccurate Reporting: In several matters it has been observed that an uncalled-for delay causes a marked deterioration in the quality of the sample collected. In cases such as the infamous 2020 Hathras incident, delays in FSL reports hampered the quality as well as the integrity of the evidence collected and was rendered to be of

[50] *Supra note 11*
[51] PRS India "The DNA Technology (Use and Application) Regulation Bill, 2019, available at: https://prsindia.org/billtrack/the-dna-technology-use-and-application-regulation-bill-2019 (last visited on 22.10.2025)
[52] Prachi Kathane, "The development, status & future of Forensics in India", 3 *Forensic Science International: Reports*, 2 (2021)

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no value and not reliable due to such a delay.[53] In the murder case of Aarushi Talwar the case demonstrated the value of forensic procedures in clarifying timeframes and recreating crime scenes. This case demonstrated the negative effects of subpar forensic procedures, including incorrect evidence processing and insufficient analysis.

c. Procedural lapses: Weaknesses persist in evidence collection protocols, improper sealing/storing of evidence, and lapses in chain of custody. Lack of standard procedures increases vulnerability to tampering and limits judicial confidence in forensic testimony.

3. Institutional Challenges:

a. Training Deficits: Only a limited number of police officers have received formal forensic training. There is a significant lack of trained forensic professionals and digital evidence specialists, further strained by inadequate ongoing training and continuing education for police and judiciary. Even among the legal professionals there is an insufficient knowledge as well as awareness pertaining to the technology involved in the collection of forensic evidence[54].

b. Dependence on Outsourcing: States which lack the proper infrastructure for forensic analysis deploy mobile forensic vans in order to seek aid of neighbouring states and thus in turn, outsource the investigation. While innovative, the reliance on such outsourced expertise risks inconsistency in quality.

c. Inter-Agency Coordination: The provisions of BNSS pertaining to forensic evidence collection and implementation demand seamless cooperation among police, judiciary, forensic departments, and other stakeholders. Shortcomings in the protocols and channels of communication can obstruct investigations, delay trials, and undermine the integrity of the justice process.

d. Backlog and Delays: Forensic labs in India have often been found to be overburdened with caseloads which far exceeds their processing capacity, resulting in significant delays which not only impede timely justice but can also affect the reliability and relevance of evidence. Furthermore, these delays are made worse by underfunding and improper handling of case systems.[55]

[53] Jignasa Sinha "FSL report (saying no rape) used samples 11 days old, has no value: Aligarh CMO", *The Indian Express*, October 5, 2020 available at: https://indianexpress.com/article/india/hathras-case-fsl-report-saying-no-rape-used-samples-11-days-old-6703136/ (last visited on: 22-10-2025)

[54] Kaushtub Mishra & Amit Singh, "Bridging the Gap: Integrating forensic science and legal frameworks in criminal justice" 10(2), *IJAR*, 144 (2024)

[55] Srishti, "The Impact of Forensic Science on the Legal System in India" 9(1) *JFSR*, 004 (2025)

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4. Ethical Challenges:
    a. DNA Profiling and Surveillance: While DNA evidence proves to be a crucial arsenal in criminal investigation the scope of its misuse is wide and pervasive. Critics of this technology warn of potential misuse of DNA databases which can be unjustifiably used for profiling or targeting minorities.[56]
    b. Bias in AI Predictive Tools: The utility of AI tools in the analysis of forensic evidence can immensely help the investigation in order to gain useful insights. However, this development is a double-edged sword as small data feeds can suffer from incorrect results and biases. Issues such as the quality of training data and algorithmic inaccuracies can impact the effectiveness of AI systems as any prejudices supplied to the AI systems are going to reflect in the results which could prove catastrophic and counterintuitive. The performance of AI systems depends heavily on the quality of the data used for training. Inaccurate, biased or incomplete data can lead to unwanted and detrimental results.[57]
5. Other Challenges:
    a. Digital Divide: This poses a major challenge across different regions in India having inconsistent status of infrastructural development. Such inconsistency leads to disparities in technological infrastructure between urban and rural areas which restrict uniform implementation of digital protocols such as e-FIRs, electronic evidence, and video-conference trials. As a matter of fact, several district courts and police stations in India still lack high-speed internet or necessary hardware, risking exacerbation of existing inequalities in access to justice.
    b. Standardization Gaps: An absence of uniform, comprehensive and nationally enforced Standard Operating Procedures for evidence collection, storage, and analysis leads to inconsistent practices and variable quality of evidence. Use of personal devices for evidentiary documentation and vague protocols for technological processes raise issues of authenticity and reliability.[58]
    c. Financial Constraints: underfunding and at times complete lack of timely and continuous funding hinder investment in essential infrastructure, advanced technology, scientific equipment, and ongoing training. Implementation of the provisions of BNSS

[56] *Ibid* note 55
[57] Praveen Dixit, "Digital detectives: Exploring the integration of artificial intelligence in Indian forensic medicine" 9(4), *IPIJFMTS* 126 (2024)
[58] *Supra* note 54

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with respect to forensic evidence collection and technology requires sustained financial allocation at both state and central levels.

d. Resistance to change: There exists an unofficial inertia to continue with the old and obsolete system as the system and its functionaries are wary of change. This manifests as considerable resistance from within law enforcement and judicial ranks to new procedures and accountability measures. This can be attributed to traditional practice habits, unwillingness to change and perceived operational inefficiencies.
e. Implementation Gap and Urban-Rural Divide: Though the transition to digital and forensic protocols is easier in metropolitan/urban centres the same cannot be said for rural and remote regions. Such areas, already hampered by lack of staff and infrastructure, also lag significantly behind in adapting and implementing the advanced and modernised provisions of the law thus risking inequitable justice delivery and undermining the code's citizen-centric aims.
f. Gaps in public awareness and civil society engagement: Successful, equitable BNSS realization requires public education, legal literacy, and the inclusion of civil society organizations in oversight and feedback mechanisms which are a few areas that currently remain underdeveloped.

VIII. Global best practices and comparative jurisprudence

Countries such as the United States, United Kingdom, Australia and members of the EU have formalized accreditation regimes, systematic SOPs, and strong court guidelines for forensic evidence. Indian law shows increasing alignment with these principles, but practical implementation still lags due to resource asymmetry and training deficits.

In the United Kingdom the Criminal Procedure Rules provide for disclosure and admissibility of forensic reports, supported by a statutory Forensic Science Regulator ensuring standards[59]. Whereas in the European Union the GDPR safeguards data privacy, while cross-border evidence is governed by mutual recognition mechanisms.[60] In the United States of America, the Daubert test requires courts to first evaluate the scientific validity of forensic techniques before admitting the evidence. In Australia the mechanism of National Forensic Science Strategy coordinates federal and state efforts. This ensures uniformity and proper resource

[59] Criminal Procedure Rules 2025, UK, Part 19 (2025)
[60] GDPR, Regulation (EU) 2016/679

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allocation.[61]

Going through these global best practices across comparative jurisprudence one can observe that compared to these countries, India lacks a uniform reliability test, a dedicated regulator, and sufficient data protection safeguards.

IX. Way Forward, recommendations and policy proposals.

For an efficient, organic and seamless integration of Forensic evidence and technology in India within the contours of the existing legal provisions a slew of steps must be taken. Some of them have been elaborated herein below:

a. Infrastructure Development: Establish forensic laboratories at the district level, supported by modern equipment and trained staff[62].
b. Judicial Guidelines: The Supreme Court or Parliament should introduce reliability tests akin to Daubert to prevent unscientific techniques from influencing trials.
c. Independent Forensic Authority: A statutory regulator can ensure quality, accreditation, and impartiality in forensic analysis.[63] A National Forensic Science Regulator (NFSR) should be established to accredit forensic laboratories and follow consistent procedures and monitor expert testimony to prevent prejudice and wrongdoing. Independent forensic review panels should be created to cross-check forensic reports.
d. Privacy Safeguards: Enacting a DNA law with strict data protection provisions will prevent misuse of genetic information.[64]
e. Capacity Building: a robust infrastructural development as well as training a large number of professionals to cater to the growing pendency of cases is the need of the hour.
f. Public Accountability: There has to be transparency in forensic processes, combined with independent audits. This will strengthen public confidence in the evidence collection and increase its authenticity.
g. Infrastructure Upgrades: The government of the day must prioritize rapid deployment of modern labs, especially in underserved states, with regular quality audits. Further,

[61] Government of Australia, *National Forensic Science Strategy* (2020)
[62] Government of India, Ministry of Home Affairs, *Committee on Reforms of Criminal Justice System* (Malimath Committee Report, 2003)
[63] Gautam Negi & Rishav Dogra, "Jurisprudence of Forensic Science in India: Analyzing the Parameters Comparatively with reference to Forensic Evidence"13(4), *IJCRT*, e738, (2025)
[64] *Supra* note 54

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the existing labs and other infrastructure should be modernised so as to meet the growing needs of modern challenges pertaining to criminal activities.

h. SOP Standardization: The legislature should formulate and enforce national SOPs for forensic evidence, from collection to reporting so as to maintain uniformity as well as clarity while upholding modern and robust standards.
i. Technology integration: This is a must so as to reap the benefits of the technological advancements. There must be specialized training modules for judges and investigators on scientific basics, digital forensics, and evidence evaluation so as to update them with the latest happenings in this field.
j. Public Awareness Campaigns: Investing in public awareness campaigns will go a long way in building public literacy about digital and forensic protocols which will reduce confusion, promote cooperation, and increase trust in the process.
k. Judicial Training in Forensic Science: A mandatory forensic training program should be implemented for Judges and prosecutors so that they might be trained in dealing with forensic evidence and may evaluate forensic reports more professionally. Only a properly trained defense counsel can dispute inaccurate forensic testimony.[65]
l. Strengthening Digital Forensics & Data Protection Laws: In view of the rising cybercrimes and other similar novel domains of crime, the provisions of the statutory legislations need to be further amended in order to equip them better to deal with the evolving crime scenario and incorporation of novel forensic technology to deal with such challenges.[66]
m. Promotion of research and development in the field of Forensic science and technology. Regular scientific improvements and innovations is necessary to keep pace with the changing national as well as global scenario pertaining to forensic science and technology. Adoption of global best practices as well as indigenous impetus on scientific innovation is necessary to excel in the field of forensic science.
n. Focus on interdisciplinary programs: There should be a promotion of courses that integrate law, science, and ethics which will produce professionals capable of bridging the gap between these disciplines.[67]

[65] *Supra* note 54
[66] *Supra* note 54
[67] *Supra* note 57

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X. Conclusion

Forensic evidence and technology can indeed transform the criminal justice system, but only if technology serves the pursuit of truth while upholding individual rights which should be non-negotiable. Ensuring that this science serves justice, rather than undermine it, must remain the central objective as well as the guiding light of adoption of forensic technology in evidence collection. At present a robust framework already exists so as to serve as a backbone for adoption of forensic evidence collection but the challenge for India does not lie in drafting progressive laws, but in creating the institutional and infrastructural ecosystem that allows those laws to be realised and fully implemented.

It can be said indubitably that integrating forensic evidence and technology in India holds immense promise but at the same time it faces deep-rooted challenges that must be addressed with humane resolve and innovation. Forensic science is more than mere mechanical scientific analysis. It is rather a voice of truth amidst chaos, shedding light on crime scenes and restoring faith in justice for victims and society alike. It has emerged as a necessity for solving the ver evolving nature of crime aided by technology. India's criminal justice system is positioned at present at a pivotal crossroads. The day by day increasing complexity of crime demands that forensic evidence collection be timely, accurate, and trustworthy. Despite this requirement, infrastructural deficits, manpower shortages, procedural gaps, and technological lag often serve as an impediment to the realisation of true potential of forensic laboratories which in turn leads to delay in justice delivery. The way forward calls for a robust investment in modern forensic infrastructure, standardization of protocols, and skilling the human resources while being amply guided by ethical imperatives. New criminal laws like the Bharatiya Nagarik Suraksha Sanhita and Bharatiya Sakshya Adhiniyam are pivotal to this adoption and implementation of forensic evidence collection technology and consequently emphasize upon forensic expertise and digital evidence, anchoring the scientific investigation deeper in the judicial process.

Beyond technology, it remains pivotal to empower the forensic professionals and foster interagency collaboration in order to nurture an ecosystem where forensic science flourishes. Transparency through videography, proper chain of custody, and judicial sensitivity to forensic findings can speed up the justice delivery mechanism while enhancing fairness. At its heart, forensic evidence is about using the best possible way to restore faith in justice delivery system, ensuring victims find their voices, the innocent are protected, and the guilty are rightly held accountable. The future of forensic technology in India is bright given that we prioritize human

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dignity alongside scientific progress. Through innovation, regulation, training, and commitment, one can remain optimistic that forensic science can truly become the unwavering pillar of justice for all.