

Review Article

The Impact of Forensic Science on the Legal System in India

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Abstract

Forensic science has significantly changed the way investigations into crimes occur by providing an approach to crime solving that is grounded in science. Since developments in investigative methods have a direct impact on litigation, its role has become increasingly important in the nation in recent years. The remarks, difficulties, and possible uses of forensic technology in the Indian legal system are discussed in this paper. By looking at case studies, legal frameworks, and forensic technology, this study emphasizes the increasing relevance of forensic science for sustaining justice, enhancing the accuracy of investigations, and overcoming problems with the use of forensic evidence in courts.

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Introduction

Forensic science plays an essential role in criminal justice by serving as an interface between scientific data and court cases. DNA testing, toxicology, pathological examination, and ballistics are just a few of the many scientific fields that are covered in forensic science and are crucial to the investigation of illicit activities. These fields have developed dramatically over time, giving courts and law enforcement reliable sources to gather information and settle disputes. The first criminal justice laboratory was established in Kolkata in 1952, marking the beginning of the slow process of integrating crime scene investigation into the Indian legal system. In recent decades, the field has grown in scope due to technological advancements [1].

Criminal science's diversity in the Indian legal system provides law enforcement organizations and courts a more credible way to establish evidence in criminal cases, enabling them to make more accurate assessments. Since it guarantees that the evidence offered in court is objective and backed by science, forensic science has emerged as a crucial instrument in inquiries into crimes. It has increased the precision of investigations and assisted in lowering mistakes in criminal justice procedures, which occasionally lead to injustices. The future development of the Indian legal system will be significantly affected by forensic science as it develops further, leading to more effective regulation and more equitable court processes [2].

Forensic science in India: An overview

The West Bengal Police established the first forensic lab

in Kolkata in 1952, marking the introduction of the criminal justice system in India. At first, India's forensic expertise was limited to basic techniques like the analysis of fingerprints, which provided little understanding of the dynamics of criminal cases. Physical evidence was the primary objective of early forensic procedures since it was vital for investigations and court cases. But as science and technology were produced, forensic procedures in India altered, employing increasingly complex and varied technologies. A crucial turning point in criminal justice was reached in the 1990s with the creation of DNA profiling, which made it feasible to identify people more precisely and use DNA evidence in linking suspects to crimes. Similarly, the emergence of toxicology in forensics made it possible to identify poisons, narcotics, and other dangerous substances with greater accuracy, which proved crucial in determining the root cause of fatalities in serious cases and conditions [3].

Other scientific specialties, such as digital forensics, developed in reaction to the increasing relevance of computers and other technological gadgets in contemporary crime as technological advances progressed. Because it enables detectives to recover and examine information saved on computers, handheld devices, and various other digital platforms, technological forensics has proven especially significant in cases regarding fraud, online crimes, and online harassment. As modern technologies like recognition of facial features, and forensic geoscience have further improved the scope and efficacy of criminal investigations, the growth of forensic science techniques in India has followed worldwide trends [4].



The Indian legal system has made substantial strides in incorporating forensic expertise into criminal investigations, acknowledging the significance of forensic evidence. To standardize forensic procedures throughout the nation, the Indian government established the Department of Forensic Science Services (DFSS) in 2001, marking the beginning of this integration. In addition to managing an extensive network of forensic labs throughout India, the DFSS has played a significant role in fostering consistency and raising the caliber of forensic analysis. There are currently more than 50 forensic labs in the nation, and this number is only going to rise as forensic science becomes more accepted by the Indian legal system [5].

Role of forensic science in criminal investigations

By presenting objective, scientifically verified evidence that can stand up to scrutiny in court, forensic analysis plays a crucial part in crime solving. Forensic subjects improve the precision and dependability of investigations into crimes by closing the gap between research and law, thereby advancing justice. The application of forensic expertise to investigations into crimes in India has proven crucial in handling complicated cases, and guaranteeing that prejudice does not skew the evidence [4].

Forensic DNA analysis

One of the most accurate and trustworthy forensic methods is generally accepted to be DNA profiling. It is increasingly essential in India for identifying offenders, solving awful crimes, and clearing innocent people. DNA is an important instrument in criminal investigations because of its distinct genetic code, which guarantees great accuracy. The case of the 2012 Delhi sex assault case was one of the historic instances where DNA analysis was essential. DNA evidence connected the offenders to the crime scene, greatly aiding in their detection and conviction. DNA testing has also been essential in solving paternity cases, missing person situations, and massive disaster identifications [6].

Forensic pathology

To ascertain the cause, procedure, and duration of death, forensic pathology performs autopsies and post-mortem examinations. This field is essential for differentiating between homicidal, suicidal, accidental, and natural deaths. Forensic pathologists are essential in violent crimes because they can shed light on the type of wounds, the kinds of weapons used, and the circumstances that led to the victim's death. Forensic pathology has been crucial in resolving cases where autopsy results revealed intentional misconduct in staged suicides or inexplicable deaths [7].

Forensic toxicology

Finding and analyzing poisonous substances in biological fluids like blood, urine, or tissues is the primary objective of forensic toxicology. In circumstances involving intoxication,

overdoses of drugs, offenses involving alcohol, and interaction with dangerous substances, it is essential. In prominent instances like the murder of Aarushi Talwar in India, where sedatives were found during the toxicological examination, forensic toxicology has played a crucial role [8].

Forensic ballistics

The study of ammunition, weapons, and bullet trajectory is known as forensic ballistics. Since it offers details about the kind of weapon used, how it fired, and the events surrounding the incident, this discipline is essential in offenses involving firearms. Forensic ballistics was essential in recreating the events and connecting the firearms used to the criminals in incidents like the 26/11 Mumbai attacks. Using microscopic striation patterns to link bullets to particular rifles has been crucial in resolving multiple firearm crime cases in India [9].

Digital forensics

Digital forensics is now an essential tool for modern investigations due to the quick development of technological advances and the rise in cybercrimes. Data recovery, analysis, and interpretation from electronic devices, including smartphones, desktops, and media for storage, are all part of digital forensics. Digital evidence frequently serves as the foundation for investigations into instances involving cyber fraud, identity theft, terrorist activity, and even more conventional crimes. For instance, information retrieved from the defendant's cell phone in the well-known Sheena Bora murder case from 2016 offered vital proof that connected conversations and incidents to the killing [10].

Forensic evidence in Indian courts

In the Indian legal system, forensic proof has become a vital instrument that greatly improves the precision and dependability of investigations into crimes and convictions. Forensic evidence still faces many legal and institutional obstacles, despite being regulated by laws like the Bharatiya Sakshya Adhiniyam, 2023. Nonetheless, its use in many well-known cases proves its indisputable contribution to achieving justice.

Challenges in admitting forensic evidence

Although forensic science has transformed the legal system, many obstacles prevent its smooth incorporation into Indian courts:

Different forensic labs have different standards: The quality and capabilities of Indian forensic labs vary widely. While certain laboratories have modern technology and knowledgeable staff that meet global requirements, others suffer from:

- * Traditional approaches and inadequate infrastructure.
- * Prolonged forensic report production delays result in drawn-out trials.

- * The absence of qualified forensic specialists makes backlogs worse.
- * The dependability of forensic evidence produced in court may vary as a result of this lack of consistency [11].

Issues of human error and misinterpretation: Despite its technical foundation, forensic evidence is vulnerable to human mistakes. Unreliable evidence gathering, processing, or interpreting can result in:

- * Disputation in court of scientific findings.
- * Possible Injustices brought on by Faulty analysis or Biased judgments.

Legal and procedural bottlenecks: Scientific evidence's validity is frequently contested because-

- * Law enforcement and judges are not well-informed about modern forensic methods.
- * Absence of precise legal guidelines for incorporating contemporary forensic technologies into court cases, such as technological forensics and AI-based investigations.
- * Inadequate chain-of-custody procedures, which might put doubt on the legitimacy of the data [11].

Landmark cases involving forensic science

In many well-known criminal cases in India, forensic science was essential to achieving justice. These incidents highlight how forensic techniques and instruments can have a profound impact:

The gang rape case in Delhi in 2012 (Nirbhaya Case): DNA profiling played a key role in locating and convicting the criminals. After gathering and examining biological specimens from the crime setting, the forensic team compared them to the accused's DNA profiles. A swift trial and conviction were guaranteed by the evidence's scientific and trustworthy quality, highlighting the significance of DNA analysis in serious crimes [12].

The murder case of aarushi talwar: Forensic pathology, DNA analysis, and fingerprint examination were all used. Notwithstanding the controversy accompanying the inquiry, 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, which caused delays and public mistrust [13].

The murder case of sheena bora: Forensic pathology identified the reason for death, while anthropological forensics played a crucial role in discovering the victim's

skeletal remains. The case highlighted the lack of access to sophisticated techniques like skeleton inspection and isotope analysis in all forensic labs, underscoring their significance [14].

Legal framework and forensic science in India

Following the implementation of three historic laws in 2023—the Bharatiya Nagarik Suraksha Sanhita (BNSS), the Bharatiya Nyaya Sanhita (BNS), and the Bharatiya Sakshya Adhinyam (BSA), India's legal system saw a dramatic change. These statutes represent an important change in the way forensic science is incorporated into criminal investigations and legal proceedings.

Bharatiya Nagarik Suraksha Sanhita, 2023 (BNSS)

Criminal investigation procedures have been upgraded under the Bharatiya Nagarik Suraksha Sanhita, 2023. This law places a strong emphasis on enhanced forensic techniques and is driven by technology the law enforcement. Important aspects of forensic science include:

- * **Required use of scientific evidence:** To provide scientific backing for crucial investigations, the BNSS requires that forensic evidence be used in cases of heinous crimes.
- * **Enhanced chain of custody requirements:** To guard against tampering, the legislation establishes strict rules for upholding the chain of custody for scientific samples, including DNA and digital evidence.
- * **Electronic evidence collection:** It describes procedures for the legal gathering and examination of digital evidence, with a focus on using accredited forensic laboratories to preserve the integrity of the evidence.
- * **Specialized forensic units:** Promotes the creation of investigative units in police forces to speed up the gathering and examination of evidence [15].

Bharatiya Nyaya Sanhita, 2023 (BNS)

The Indian Penal Code is replaced by the Bharatiya Nyaya Sanhita, 2023, which also includes progressive amendments to improve the administration of justice. It illustrates how crucial forensic evidence is becoming to criminal prosecution. It consists of the following-

- * **Incorporation of scientific-based offenses:** The BNS specifically acknowledges crimes including illicit drug trafficking, online crimes, and ecological offenses that call for forensic assistance.
- * **Forensic expert testimonies:** To enable forensic experts to offer specialized views during trials, rules for expert testimony are strengthened.

- * **Punishment measures for evidence tampering:** To ensure the integrity and dependability of forensic evidence in court, the legislation establishes harsh penalties for tampering with it.
- * **Role of advanced forensic technology:** To provide a futuristic approach to crime solving by encouraging the use of modern technologies like Artificial Intelligence (AI) and the analysis of DNA in investigations [16].

Bharatiya Sakshya Adhiniyam, 2023 (BSA)

The Bharatiya Sakshya Adhiniyam, 2023, redefines the dependability and admissibility of evidence in court, especially forensic evidence. Important clauses consist of:

- * **Acknowledgment of contemporary forensic methods:** Broadens the scope of evidence admissible to encompass findings from contemporary forensic methods.
- * **Digital evidence authentication:** To ensure adherence to accepted forensic standards, the act adds particular rules for the identification of digital and electronic evidence.
- * **Simplifying expert testimonies:** It codifies the procedure for forensic expert testimony presentations, necessitating thorough justifications of methods and conclusions to improve transparency and intelligibility.
- * **Protection of specialists and witnesses:** Offers safeguards to protect forensic specialists and witnesses from injury or intimidation, guaranteeing their impartial involvement in court cases [15].

Challenges and issues

Lack of standardization

The absence of uniformity among forensic labs is one of the main issues facing forensic science in India. Many labs use antiquated equipment and don't follow a standard procedure for forensic analysis. As a result, the caliber of forensic evidence offered in court varies. To guarantee consistency and legitimacy in forensic procedures, the Bureau of Police Research and Development (BPRD) has underlined the necessity of forensic lab accreditation by organizations such as the National Accreditation Board for Testing and Calibration Laboratories (NABL) [17].

Delay in forensic reports

Substantial congestion of cases affects Indian forensic labs, which frequently gets triggered by a lack of people and resources. The system of justice may be jeopardized by these delays since they may hinder crucial cases that need prompt forensic proof. These delays are made worse by insufficient financing and improper handling of case systems. Modernizing the forensic infrastructure and boosting government funding are necessary to address these problems.

Training and expertise

The quick development of forensic science, especially in the areas of computer forensics and toxicology for forensic use, has led to a disconnect between the needs of technology and the knowledge that is currently accessible. Due to a lack of skilled forensic experts, India is forced to use antiquated techniques. To address the increasing need for qualified forensic specialists, efforts to improve education and training for the police and forensic staff as well as partnerships with educational institutions are crucial.

Public awareness

In India, the general public frequently has a negative opinion of forensic science, which breeds doubt about its dependability and accuracy. The legal system and police are also impacted by this ignorance, which leads to a lack of use of forensic resources. To increase confidence in forensic evidence, awareness-raising initiatives such as seminars, educational events, and training for law enforcement and court personnel are essential [17].

Future directions

Standardization of forensic practices

To guarantee the uniformity of forensic procedures across the country, India requires a single framework. This entails establishing consistent procedures for gathering, preserving, analyzing, and submitting evidence. Adoption of global norms like ISO 17025 for forensic laboratories and certification by organizations like the National Accreditation Board for Testing and Calibration Laboratories (NABL) are essential first steps. Inconsistencies can be resolved and the validity of forensic proof offered in court can be guaranteed with the assistance of a centralized compliance tracking organization [18].

Use of advanced technology

Criminal justice in India could change with the use of cutting-edge technology like blockchain, deep learning, and Artificial Intelligence (AI). AI and ML can help with complex dataset analysis, automate repetitive forensic operations, and increase the accuracy of DNA and fingerprint examinations. Criminal records can be shared and stored securely and impenetrably thanks to blockchain technology. These technologies can be incorporated into forensic services through government programs like the Digital India plan.

Improvement in training and infrastructure

To satisfy the increasing demand for forensic assistance, it is imperative to upgrade the structure of laboratory facilities and improve the education of forensic professionals. Specialized training programs can be facilitated through partnerships with international forensic organizations and educational institutions. Furthermore, modernizing labs with state-of-the-art equipment such as DNA sequencers, 3D imaging systems, and sophisticated digital forensics software should be a top priority for government spending.

Author's perspective & recommendations

The authors view the new laws and regulations as a transformative initiative that integrates forensic science into the justice system to promote evidence-based investigations and timely resolutions. They highlight its potential to improve conviction rates and reduce trial delays. However, challenges such as inadequate forensic infrastructure, a shortage of trained experts, and limited awareness among stakeholders persist.

To address these issues, the authors recommend establishing advanced forensic laboratories across states, enhancing capacity building through regular training for law enforcement and judicial officers, and integrating forensic education into academic curricula. Additionally, public awareness campaigns are suggested to foster an understanding of forensic science's role in justice delivery, ensuring effective implementation of the new legal provisions.

Discussion

The integration of forensic science into India's criminal justice system through the new laws represents a significant advancement in evidence-based adjudication. By mandating the inclusion of forensic reports in judicial processes, the new laws and regulations reinforce the importance of scientific evidence in ensuring accurate and fair outcomes, particularly in complex cases like sexual offenses, drug abuse, and violent crimes. This move reduces reliance on subjective testimonies and bolsters judicial credibility.

Additionally, the focus on training judicial officers and law enforcement personnel in forensic science addresses critical knowledge gaps, fostering informed decision-making and enhancing trust in scientific methodologies. However, challenges such as the shortage of forensic experts, inadequate infrastructure, and limited accredited laboratories may hinder the timely implementation of these provisions. The integration of advanced tools, including DNA profiling and digital forensic technologies, will further augment the effectiveness of the justice system, ensuring swift and accurate resolution of cases.

Conclusion

The examination and settlement of criminal cases are greatly improved by forensic science, which has emerged as an essential part of the Indian judicial system. By offering scientifically sound evidence, it has improved the legal system by raising the possibility of correct verdicts and lowering the possibility of injustices. The way investigations into crimes are conducted in India has been completely transformed by the incorporation of forensic technology like toxicology, digital forensics, and DNA profiling.

The absence of uniformity, forensic processing delays, inadequate facilities, and a lack of qualified personnel are still major barriers, nevertheless. Criminal justice in India must

continue to progress by addressing these problems through uniform processes, cutting-edge training, technological investment, and public awareness initiatives.

The importance of the forensic field will only increase as India moves closer to upgrading its criminal justice and investigative systems. The legal system is poised for a radical change because of reforms like the new regulations and judges' growing acceptance of forensic evidence. India can guarantee an era where justice is both prompt and accurate, protecting the rights of all individuals, by giving priority to investment in forensics facilities and encouraging increased cooperation between science and legal specialists.

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