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A STUDY ON THE RELIABILITY AND ADMISSIBILITY OF FORENSIC EVIDENCE IN COURTS UNDER THE BHARATIYA SAKSHYA ADHINIYAM, 2023

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Abstract

Forensic evidence occupies a central position in contemporary criminal adjudication. The rapid advancement of scientific techniques—particularly DNA profiling, fingerprint analysis, ballistic examination and digital forensics—has significantly influenced the fact-finding process of courts. However, the perceived infallibility of forensic science has increasingly been questioned in light of documented errors, laboratory failures and wrongful convictions across jurisdictions. The enactment of the Bharatiya Sakshya Adhinyam, 2023 (BSA), which replaces the Indian Evidence Act, 1872, marks an important transition in India's evidentiary regime. This paper critically analyses the reliability and admissibility of forensic evidence under the BSA framework, evaluates judicial approaches, identifies systemic and procedural challenges, and proposes reforms necessary to strengthen evidentiary integrity in India's criminal justice system. The research finds that while the BSA strengthens the role of forensic evidence—especially digital records—it still depends heavily on proper collection methods, certification requirements, and judicial scrutiny to ensure fairness. The study concludes that forensic evidence can significantly improve conviction accuracy only when supported by robust procedural compliance, trained forensic infrastructure, and vigilant judicial oversight.

Introduction

The relationship between law and science has undergone a profound transformation in the last few decades. Criminal investigations that once depended primarily on eyewitness accounts and confessional statements now increasingly rely on scientific techniques. Forensic science has become a powerful investigative aid capable of linking suspects to crime scenes, reconstructing criminal events and corroborating testimonial evidence.

In India, the growing institutionalization of forensic laboratories and the rising use of DNA technology, cyber forensics and advanced analytical tools reflect this transformation.

Courts often attach significant weight to scientific evidence because of its perceived objectivity. Nevertheless, global experience demonstrates that forensic evidence is not immune from error. Problems such as contamination, overstated expert testimony, lack of standardization, cognitive bias and weak laboratory oversight have contributed to miscarriages of justice in several jurisdictions.

The Bharatiya Sakshya Adhinyam, 2023 seeks to modernize the law of evidence in India by reorganizing provisions and adapting them to contemporary technological realities. While the new statute retains many foundational principles of the earlier law, it also places

renewed emphasis on electronic and scientific evidence. In this context, it becomes necessary to critically examine whether the present legal framework adequately safeguards against unreliable or improperly admitted forensic evidence.

This paper therefore explores the twin pillars of reliability and admissibility under the BSA regime, analyses judicial trends, and suggests reforms required to ensure that forensic science strengthens rather than undermines the fairness of criminal trials.

Nature and Scope of Forensic Evidence

Forensic evidence refers to information obtained through the application of scientific methods to material relevant for legal proceedings. It represents the intersection of science and law, where technical findings are translated into legally meaningful facts. The scope of forensic science has expanded dramatically with technological progress.

Major categories of forensic evidence include DNA and biological profiling, fingerprint examination, firearms and ballistic analysis, forensic toxicology, cyber and digital forensics, questioned document examination and bloodstain pattern analysis. Each of these disciplines relies on different scientific principles and therefore varies in its degree of reliability.

DNA profiling is widely regarded as one of the most robust forensic tools when proper collection and laboratory protocols are followed. By contrast, some pattern-matching disciplines—such as bite-mark analysis or certain forms of handwriting comparison—have faced criticism regarding their empirical validation. Courts must therefore avoid treating all forensic techniques as equally reliable.

The evidentiary value of forensic material lies in its ability to either implicate or exclude individuals. It may establish identity, link a suspect to a crime scene, determine cause of death or authenticate digital activity. However, forensic findings are ultimately interpretive and

probabilistic in nature, which necessitates cautious judicial evaluation.

Legal Framework under the BSA

The Bharatiya Sakshya Adhiniyam, 2023 represents a structural reorganization of India's law of evidence. Although the new statute substantially retains the substantive principles of the earlier regime, it renumbers provisions and seeks to align evidentiary rules with modern technological developments, particularly in relation to electronic evidence.

Section 39 of the BSA governs the admissibility of expert opinion. The provision permits courts to rely on opinions of persons specially skilled in science, foreign law, art or technical fields. This continues the long-standing recognition that judges may require assistance from subject-matter experts when dealing with complex scientific issues.¹⁹⁸¹

However, the statute maintains the traditional position that expert opinion is advisory in nature. The court is not bound by the expert's conclusion and must independently assess the credibility of the testimony, the qualifications of the expert and the reliability of the methodology employed. Supporting provisions allow inquiry into the grounds of expert opinion and regulate admissibility of electronic records.

Thus, while the BSA modernizes evidentiary structure, the responsibility of judicial gatekeeping remains central to preventing misuse of forensic science.

Types of forensic evidence :

Biological (DNA) Evidence

Biological evidence consists of material derived from the human body or other living organisms and is considered one of the most powerful forms of forensic proof. Common sources include blood, semen, saliva, hair with root, skin cells, bones, and teeth. The primary scientific tool used in analysing such evidence is DNA profiling, which is based on the principle that every individual, except identical twins,

¹⁹⁸¹ Bharatiya Sakshya Adhiniyam, 2023

possesses a unique genetic makeup. In criminal investigations, DNA evidence is extensively used to identify suspects, establish paternity, connect the accused with the crime scene, and identify unknown dead bodies.

The reliability of DNA evidence is extremely high when proper scientific protocols are followed. Even minute biological samples can yield accurate results. However, the evidentiary value of DNA depends heavily on maintaining an unbroken chain of custody and preventing contamination. Improper collection, degradation due to environmental exposure, and laboratory errors can weaken its probative value. Indian courts generally treat DNA evidence as highly persuasive but still insist on procedural safeguards before relying upon it conclusively.

Fingerprint Evidence

Fingerprint evidence is based on the long-established scientific principle that the ridge patterns on human fingers are unique and remain unchanged throughout life. Fingerprints are commonly classified into latent prints, which are invisible and require chemical development; patent prints, which are visible to the naked eye; and plastic prints, which are impressions left on soft surfaces like wax or clay. In criminal investigations, fingerprint analysis is frequently used to identify suspects and link individuals to specific objects or locations.

The strength of fingerprint evidence lies in its individuality and long history of judicial acceptance. It is relatively inexpensive and widely used by investigative agencies. However, its reliability may be affected when only partial or smudged prints are available. Environmental conditions may also damage prints, and expert comparison is required for proper identification. Courts in India generally accept fingerprint evidence when it is collected and analysed by qualified experts following proper procedures.

Ballistic Evidence

Ballistic evidence relates to firearms, bullets, cartridges, and the scientific examination of

their characteristics. This branch of forensic science helps investigators determine whether a particular bullet was fired from a specific weapon. It also assists in reconstructing the trajectory of the bullet, estimating the firing distance, and analysing gunshot residue. Ballistic examination plays a crucial role in cases involving homicide, attempted murder, and illegal possession of firearms.

The scientific basis of ballistics lies in the fact that every firearm leaves unique microscopic marks on the bullet due to the rifling inside the barrel. When properly recovered and preserved, bullets and cartridge cases can be matched with considerable accuracy. Nevertheless, ballistic evidence has certain limitations. Damaged bullets, poor recovery techniques, or absence of the suspected weapon may reduce its evidentiary value. Moreover, the conclusions are often expert-driven and usually require corroboration. Courts treat ballistic reports as important but not conclusive proof.

Digital and Electronic Evidence

In the digital age, electronic evidence has emerged as one of the most significant forms of forensic material. Digital evidence includes emails, text messages, WhatsApp chats, CCTV footage, mobile phone data, hard disk contents, server logs, and GPS records. With the rapid increase in cybercrime and technology-assisted offences, courts increasingly rely on such evidence to establish timelines, communications, and presence of the accused at relevant locations.

The Bharatiya Sakshya Adhiniyam, 2023 has given electronic records the same legal status as traditional documents, subject to compliance with prescribed certification requirements. Digital evidence is particularly valuable because it is often time-stamped and capable of precise reconstruction of events. However, it is also highly vulnerable to manipulation, editing, and fabrication. Emerging threats such as deepfake technology and metadata tampering pose serious challenges. Therefore, courts insist on strict compliance with

procedural requirements, including proper certification and proof of authenticity, before admitting electronic evidence.

Trace Evidence

Trace evidence refers to minute materials that are transferred between persons, objects, or environments during the commission of a crime. This category includes fibres, glass fragments, paint chips, soil particles, and gunshot residue. The scientific foundation of trace evidence lies in Locard's Exchange Principle, which states that every contact leaves a trace. Even when large pieces of evidence are absent, microscopic trace materials can help link a suspect to a crime scene or victim.

Trace evidence is particularly valuable in circumstantial cases where direct evidence is lacking. It can help reconstruct movements and interactions involved in the crime. However, because such evidence is often present in very small quantities, it requires sophisticated laboratory analysis and careful handling. There is also a risk of secondary transfer, which may create misleading inferences if not properly interpreted. Courts generally treat trace evidence as corroborative rather than standalone proof.

Document and Handwriting Evidence

Document examination is an important branch of forensic science that deals with the authenticity of written or printed materials. It includes handwriting comparison, signature verification, detection of forgery, ink analysis, paper examination, and identification of alterations in documents. Such evidence frequently arises in cases involving fraud, forgery, disputed wills, property transactions, and financial crimes.

Handwriting experts analyse characteristics such as stroke pattern, spacing, pressure, and letter formation to determine authorship. Although scientific techniques are used, courts traditionally exercise caution while relying solely on handwriting opinion because natural variations in writing and skilled forgery can

sometimes create uncertainty. Consequently, judicial practice prefers corroboration of handwriting evidence with other independent proof before drawing final conclusions.

Medical and Post-Mortem Evidence

Medical evidence is provided by qualified medical practitioners and forensic pathologists. It includes injury reports, post-mortem examinations, age determination, cause of death analysis, and sexual assault examination reports. In criminal trials, medical evidence plays a vital role in establishing the nature of injuries, time and cause of death, and the manner in which the offence may have occurred.

Post-mortem reports are particularly important in homicide and suspicious death cases because they help reconstruct the circumstances leading to death. Medical evidence is generally considered reliable because it is based on scientific examination of the human body. However, it remains an expert opinion and may sometimes involve interpretational differences between medical professionals. Courts therefore evaluate medical evidence carefully and in conjunction with other evidence on record.

Toxicological Evidence

Toxicological evidence involves the scientific detection of poisons, drugs, alcohol, and other chemical substances in the human body. Samples commonly analysed include blood, urine, viscera, hair, and stomach contents. Toxicology is crucial in cases of suspected poisoning, drug overdose, intoxication, and certain suspicious deaths.

The strength of toxicological evidence lies in its laboratory-based and quantifiable nature. It can conclusively establish the presence and concentration of harmful substances in the body. However, its reliability depends on timely collection and proper preservation of samples, as decomposition and environmental factors may affect results. When properly conducted, toxicology reports often become decisive

evidence, particularly in poisoning and narcotics cases.

Reliability of Forensic Evidence

The reliability of forensic evidence depends fundamentally on the scientific validity of the technique employed and the integrity of its application in a particular case. A forensic method should ideally be supported by empirical testing, peer review, known error rates, standardized operating procedures and reproducibility of results.

DNA profiling generally satisfies these criteria when laboratories follow proper collection, preservation and analytical protocols. Nevertheless, even highly reliable techniques can produce erroneous results if procedures are not strictly followed.

Several factors may undermine reliability. Human error during collection, labeling or analysis remains a persistent risk. Contamination of biological samples may introduce foreign material. Cognitive bias may influence expert interpretation, particularly when analysts are exposed to investigative expectations. In addition, infrastructural limitations and heavy case backlogs in forensic laboratories can affect quality control.

Courts must therefore adopt a scientifically informed approach that evaluates not only the theoretical validity of the technique but also the manner in which it was applied in the case at hand.

Reliability of Forensic Techniques

Reliability refers to the scientific soundness and accuracy of the method employed. Forensic evidence should ideally be based on techniques that are empirically tested and capable of producing consistent results.

Indicators of Scientific Reliability

A forensic method is generally considered reliable when it demonstrates:

- Empirical validation through testing,
- Peer-reviewed acceptance,

- Known and low error rates,
- Standardized operating procedures, and
- Reproducibility of results.

DNA profiling typically satisfies most of these criteria when proper protocols are followed.

Factors Undermining Reliability

Despite scientific advancement, several practical issues may reduce reliability.

Human error: Mistakes in collection, packaging, labeling, or analysis can compromise evidence.

Contamination: Improper handling may introduce foreign biological material.

Cognitive bias: Experts may unconsciously interpret findings in a manner that supports investigative theories.

Overstatement: Some experts present probabilistic findings as absolute certainty, which misleads courts.

Infrastructure gaps: Many forensic laboratories in India face shortages of trained personnel and modern equipment.

Judicial Approach in India

Indian courts have historically treated expert evidence with caution. Judicial decisions consistently emphasize that expert testimony is only one component of the evidentiary matrix and cannot substitute the court's independent evaluation. Cross-examination of experts and corroboration from other evidence remain important safeguards.

In recent years, however, courts have shown increasing confidence in properly collected DNA evidence. High-profile criminal cases demonstrate the growing persuasive value of scientific proof. At the same time, courts continue to insist on strict compliance with procedural requirements, particularly in relation to electronic evidence.

The emerging judicial trend may therefore be described as cautious acceptance—welcoming scientific assistance while remaining alert to the possibility of error. This balanced approach must continue under the BSA regime.

Indian courts have repeatedly examined the evidentiary value of forensic science and expert testimony while laying down important safeguards. In *State of H.P. v. Jai Lal*,¹⁹⁸² the Supreme Court held that expert opinion is advisory in character and must be evaluated along with other evidence on record. The Court cautioned that judges should not surrender their independent judgment merely because a scientific expert has expressed a view. Earlier, in *Murari Lal v. State of Madhya Pradesh*,¹⁹⁸³ the Court described expert evidence as a weak type of evidence if not properly tested, emphasizing the need for careful scrutiny and corroboration.

The judiciary has, however, shown growing acceptance of scientifically reliable techniques. In *Pattu Rajan v. State of Tamil Nadu*¹⁹⁸⁴, the Supreme Court recognized DNA profiling as an extremely accurate form of identification but stressed that the prosecution must establish an unbroken chain of custody. Similarly, in *Santosh Kumar Singh v. State*¹⁹⁸⁵, the Delhi High Court relied substantially on DNA evidence in affirming conviction, reflecting the increasing probative value attached to modern forensic methods. At the same time, constitutional limitations remain significant; in *Selvi v. State of Karnataka*¹⁹⁸⁶, the Supreme Court held that involuntary narco-analysis, polygraph, and BEAP tests violate the right against self-incrimination, thereby placing substantive limits on certain investigative techniques. Collectively, these decisions demonstrate that Indian courts adopt a balanced approach—recognizing the growing importance of forensic science while insisting upon strict procedural safeguards and judicial oversight.

Challenges under the BSA Regime

Despite statutory modernization, several systemic challenges persist. India does not yet have a detailed statutory reliability test comparable to the Daubert standard followed

in the United States. As a result, admissibility determinations depend heavily on judicial discretion, which may lead to inconsistency.

Forensic infrastructure also remains uneven. Many laboratories face shortages of trained personnel, outdated equipment and significant case backlogs. These constraints may affect the timeliness and quality of forensic analysis.

Chain of custody deficiencies constitute another major concern. Breaks in documentation regarding seizure, storage or transfer of evidence can cast serious doubt on authenticity. Similarly, procedural non-compliance in certification of electronic evidence frequently results in exclusion by courts.

Practical Challenges Affecting Admissibility

Lack of Uniform Standards

India does not yet have a comprehensive statutory test equivalent to the Daubert standard used in the United States. This leads to inconsistency in judicial evaluation.

Forensic Laboratory Constraints

Common issues include:

- Case backlogs
- Inadequate funding
- Uneven accreditation
- Shortage of trained experts

Chain of Custody Issues

Breaks or gaps in documentation regarding the handling of evidence can cast serious doubt on authenticity.

Procedural Non-Compliance in Digital Evidence

Failure to comply with statutory certification requirements frequently results in the rejection of electronic evidence.

Overdependence by Courts

There is a tendency in some cases to treat forensic reports as decisive proof, which is legally unsound. There is also a continuing risk of overreliance on forensic reports. Scientific

¹⁹⁸² 7 SCC 280

¹⁹⁸³ 1 SCC 704

¹⁹⁸⁴ 4 SCC 771

¹⁹⁸⁵ 9 SCC 747

¹⁹⁸⁶ 7 SCC 263

evidence, though powerful, should never be treated as automatically conclusive.

Comparative Perspective

Comparative experience provides valuable guidance. In the United States, courts apply a structured admissibility test focusing on scientific validity, peer review and error rates. The United Kingdom has strengthened quality assurance through an independent forensic science regulator. These models highlight the importance of institutional oversight and methodological transparency.

India can draw lessons from these jurisdictions while adapting reforms to domestic conditions. Strengthening accreditation systems and developing clearer admissibility standards would significantly enhance confidence in forensic evidence.

Recent Developments in India

India has witnessed significant developments in the treatment of forensic evidence, particularly with the enactment of the Bharatiya Sakshya Adhiniyam, 2023 (BSA) and parallel institutional reforms. The BSA replaces the Indian Evidence Act, 1872 and modernizes evidentiary rules to align with contemporary scientific and digital realities. Section 39 of the BSA continues to recognize expert opinion as relevant evidence but reinforces the principle that such opinions are advisory and must be judicially scrutinized.

One of the most notable developments is the increased judicial reliance on DNA profiling. Indian courts, including the Supreme Court and various High Courts, have repeatedly affirmed that properly conducted DNA evidence carries strong probative value, especially in cases involving sexual offences, paternity disputes, and violent crimes. However, courts have also cautioned that DNA reports must be supported by an unbroken chain of custody and proper laboratory procedures.

Institutionally, the Government of India has expanded forensic capacity through the strengthening of the Directorate of Forensic Science Services (DFSS) and the establishment

of additional Central and State Forensic Science Laboratories. Efforts are also underway to improve laboratory accreditation under the National Accreditation Board for Testing and Calibration Laboratories (NABL) framework, which aims to enhance reliability and standardization.

Another major development is the growing emphasis on digital and cyber forensics. With the rise in electronic evidence, courts are increasingly dealing with mobile data extraction, CCTV footage, and metadata analysis. The new criminal law reforms (2023) also encourage greater scientific investigation, including mandatory forensic examination in certain serious offences.¹⁹⁸⁷

At the same time, concerns remain. Indian courts continue to face issues such as:

- Shortage of trained forensic experts
- Delays in forensic reports
- Inconsistent laboratory standards
- Risk of overreliance on expert testimony

Overall, the recent trajectory in India shows greater institutionalization and acceptance of forensic science, but with a parallel judicial insistence on procedural safeguards. The success of the BSA framework will ultimately depend on strengthening forensic infrastructure, ensuring accreditation, and maintaining rigorous judicial gatekeeping.

Suggestions and Recommendations

Several reforms are necessary to strengthen the reliability and admissibility of forensic evidence in India. First, Parliament may consider introducing a structured statutory screening test requiring courts to evaluate the scientific validity of expert evidence before admission.

Second, accreditation of forensic laboratories should be made mandatory and subject to periodic independent audits. Third, expert witnesses should be required to undergo certification and continuing professional training. Fourth, digital chain-of-custody

¹⁹⁸⁷ Bharatiya Sakshya Adhiniyam, 2023

systems should be implemented to minimize tampering risks.

Fifth, specialized training programs should be conducted for judges, prosecutors and defence lawyers to improve scientific literacy. Finally, establishment of an independent national forensic regulatory authority would provide much-needed oversight and promote uniform standards across the country.

Conclusion

Forensic science has undoubtedly enhanced the truth-finding function of criminal courts. When properly applied, it can both secure convictions of the guilty and protect the innocent. However, the reliability of forensic evidence cannot be presumed. Scientific limitations, human fallibility and procedural lapses continue to pose significant risks.

The Bharatiya Sakshya Adhinyam, 2023 modernizes India's evidentiary framework but does not by itself eliminate these concerns. Effective implementation, institutional strengthening and vigilant judicial scrutiny remain essential.

Ultimately, forensic evidence should assist—not replace—the court's independent reasoning. A balanced approach combining scientific advancement with robust legal safeguards is necessary to ensure that forensic science truly serves the cause of justice.

