

ROLE OF FORENSIC EVIDENCE IN INDIAN CRIMINAL JUSTICE SYSTEM

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ABSTRACT

An essential component of contemporary criminal investigations, forensic evidence serves as a lighthouse that directs the search for justice and the truth in the Indian judicial system. By highlighting its significant influence on the administration of justice, this study aims to clarify the crucial role that forensic evidence plays in criminal investigations. This research begins with an overview of forensic science and its development in India. It then goes into great depth on the many types of forensic evidence, including digital, biological, physical, and trace evidence. Highlighting the developments in the area is a thorough review of cutting-edge forensic technology and methods, including ballistics, DNA analysis, fingerprint analysis, and cyber forensic approaches. The legal framework that governs the use of forensic evidence in India is examined, including a detailed examination of current laws, rules, and the admission of such evidence in court. Furthermore, the study recognizes and tackles a number of obstacles and restrictions related to the incorporation of forensic evidence into criminal investigations, such as the urgent problem of backlogs, resource limitations, and the necessity of guaranteeing quality and uniformity. Insightful case examples that highlight the significant impact forensic evidence has had on criminal case results and further highlight its critical function in the criminal justice system enhance the article.

KEYWORDS: Forensic , criminal , investigation , evidence , ballistics

INTRODUCTION

Forensic evidence is a significant interface of technology and law in modern criminal investigations. Put simply, forensic science involves the application of scientific methods and principles for the purpose of answering pertinent questions within a legal context, most notably crime cases. In this class of evidence, there is such a broad spectrum of scientific findings, ranging from DNA and fingerprints to toxicology reports and digital footprints. Although such evidence is still useful just to identify the suspects, it can also be used to retrace events, verify testimonies, and, ultimately, to aid the justice system in a fair and truthful verdict.

Forensic evidence has become a matter of importance in India during the past few decades. Nevertheless, there is a trend towards

a direction of objectivity and accuracy in criminal enquiries that ultimately results in an enhancement of the use of forensic science in the Indian criminal justice system. Forensic evidence can offer persuasive, and to admit to ambiguity, evidence which cannot be ignored when wrestling with witness testimony or circumstantial issues. Since in this forensic evidence the nature is objective, in this situation the situation of great relevance is on highload cases, in which the reliability of evidence can determine whether the conviction or an acquittal is granted.

▪ Definition and Scope

Forensic evidence, the study of process and practices for obtaining and interpreting the information that can be used in court to better understand criminal behaviour. Such evidence can be categorized as physical (fingerprints,

bloodstains, and DNA) and digital (of electronic devices) which is often central in constructing a fact scenario of how a crime might have been perpetrated and who might have been involved in it.

In an Indian scenario, forensic evidence has been assigned a central position because of the complexities of modern day criminal investigations on the one hand, and the societal attitude of expecting scientifically sound evidence for a fair trial in the court of justice, on the other. Forensics plays an important role both in the course of an investigation and in the trial process thereby enabling investigators to obtain conclusive evidence of guilt or innocence that can of course have a trial effect with the result of conviction or acquittal of accused persons. In parallel with the advances in technology, forensics evidence has expanded beyond the common evidence (e.g., fingerprints but, instead) up to, for example, DNA profiling, and cyber forensic investigation, etc. Every one of these methods is a step towards a more accurate, sturdy, solution to the problem of crime solving when objectivity and scientific justness can be used to prevent an incorrect conviction and to achieve a just result.

Forensic evidence is a nexus of science and law, on which judicial pronouncements can be grounded. Its hope to generate sciencebased answers to forensically posed problems of India's law and society is still at an initial stage of the criminal justice system in India.

▪ Historical Development of Forensic Evidence in India

The development and evolution of forensic science in India is a tale of slow achievement. Though forensic science has ancient roots globally—traceable back to cultures that examined bloodstains or studied poisons—India's formal journey with forensic science started relatively recently, in the early 20th century. The first forensic laboratory in India was set up in 1952, with profound consequences for the Indian criminal justice system. This first lab served as a starting point for the provision of

some basic forensic laboratory services, chemistry and serology related, building for a more science based solution to criminal investigations.

Over the years, India has been building up its forensic capability in the context of growing and complex criminal landscape. During the 1980s forensic practices in India began to employ increasingly sophisticated molecular and analytical techniques (fingerprint analysis and ballistics). Though, only in 1990s, with the worldwide acknowledgement of the DNA testing, the forensic science became the sensation in India. DNA evidence changed criminal processes by enabling investigators to solve cases previously thought to be impossible.

Today, forensic science has a robust presence in India. Across the state and federal levels, an epidemic of forensic laboratories exists throughout the United States, including forensic analysis that is not limited to, digital forensics, toxicology, cyber forensics, and many others. Nonetheless, at present, the forensic system of India is limited on the grounds of the deficient wing, such as manpower, training and evidence backlog, to an extent, these can limit the present state of forensic evidence in court.. However, from the other side, the evolutionary history of incorporating forensic science in the system of administration of justice in India is also a record of the evolution of scientific criminal investigation process in India and at last achieving a reasonable and scientific accuracy rather than only the outcome.

The evolution and use of forensic evidence development and application in India, in particular, has been an exciting track with the help of key judgments, which has laid the foundation of judicial precedents.

One of the most striking is State of Uttar Pradesh v. Ram Babu Mishra (1980)⁹¹⁴, in which the Supreme Court emphasized the contribution of forensic science to criminal investigations, and indicated, that wrongful negligence in proper

⁹¹⁴ State of U.P. v. Ram Babu Mishra, A.I.R. 1980 S.C. 791

forensic examination may ruin the case. A very important case is *M. S. K. Jha v. State of Bihar* (1999)⁹¹⁵, which emphasized the role of DNA profiling in identity confirmation, which thus opened the view that DNA testing is an essential tool in forensic science. Additionally, the *K. K. Varma v. State of U.P.* (1988) confirmed the validity of using ballistic data to link a suspect to a murder weapon, and as a result emphasized the role of forensic evidence by which to uphold fairness.

These cases are a sign of the rising quantum of forensic evidence in the Indian criminal justice system and, as such, it is important in determining criminal matter. The recent advancements in forensic science are offering instruments to attain more authentic, efficacious results in crime law domain thereby enhancing the trustworthiness of the justice delivery system in India.

Taken together, these developments have made forensic evidence a valuable tool for Indian criminal justice, for facilitating investigations, but also for affording justice and truthfulness in the criminal justice system.

TYPES OF FORENSIC EVIDENCE

Forensic evidence is the tip of the iceberg in the forensic investigation, in order to identify suspects in criminal offences/to rule out innocent persons. Synopsis A review of the variety of forensic evidence and the merits of each in the investigation and prosecution of criminal offences is presented.

1. Physical Evidence

It's something you can see, touch, and measure. However, it can reveal a lot when properly analyzed. For instance: It is possible to identify a person who came into contact with the surface by analysis of the fingerprint on the surface.

Weapons may establish the linkage between the suspected offender and the crime scene in terms of fingerprints and/or trace marking, e.g., gunshot residue.

Tire tracks/prints can be used as information on type of vehicle or on the identification of footwear and also can be used as a guidance in interviewing a suspect.

Physical evidence is of significant value in India, because of its ease of availability and applicability in resourceconstrained scenarios where advance forensic techniques may not be feasible in most cases. It is a freely available telecommunication channel from the events of the crime scene to actors, a kind of connection into the craziness of the forensic jigsaw.

2. Biological Evidence

Biological evidence refers to any data extracted from a living injured/menced tissue, most of the time victim or perpetrator, and can be DNA, mainly body fluids, e.g., blood, hair, saliva, or secretions. The genetic code [DNA] is unique to all organisms and, as such, can be very strictly applied to obtain maximum possible specificity in the case of maximal certainty and is one of the most reliable types of forensic evidence.

Examples of biological evidence include

Hair/skin cells from which DNA is easily extractable (even if in very small amounts) can be used as a cyanide trace between a subject and a place or a manufactured object.

Biological fluids (e.g., spit or sweat) with the potential to be deposited, onto an object touched or handled by a suspect during encounters.

In India, biological evidence played a crucial role in sensitive crime investigations, e.g., the Nirbhaya case, in which biological evidence offered compelling support to the perpetrator's attribution and involvement. It is very reproducible, however, it may be also impractical due to special need of facilities or techniques& special reagents such as DNA content analysis/information.

3. Trace Evidence

There is the tiny evidence (i.e., it can be a transport material that can never be detected, can be carried from one person to another or

⁹¹⁵ *M.S.K. Jha v. State of Bihar*, A.I.R. 1999 S.C. 1257

from one location to another and linking one of the two entities). Trace evidence is typically microscopic and may need to be viewed by a forensic professional, yet it can be highly informative. Examples include:

Fibers, from textiles or carpeting, that could give evidence of the presence of a perpetrator in a particular area or the exposure to a particular person.

Glass waste's that still adhere to items of clothing after a burglary for which it may be legally charged on an offender .

Soil or pollen particles collected on the shoe of a suspect that might be compared to soil samples taken from the scene of the crime and, further, indicating that they were present in the vicinity.

Trace evidence is defined by the maxim "all contacts are traces," an adage coined by psychiatric forensic scientist Edmond Locard and which continues to be relevant today. Trace evidence is performed at the forensic level in India as an alternative to circumstantial evidence (e.g., witness testimony) when other evidence is not available or it is difficult to extract a meaningful interpretation. Although they are short, these traces have the capability of being a most important component of the evidence when used with the other evidence.

4. Ballistic Evidence

This branch focuses on firearms and ammunition. Ballistic people can analyse bullets and cartridge cases to uncover which weapon has been fired, the angle from which shots have been taken, and associate a particular bullet with a particular weapon. Such evidence is of practical value in forensic investigations of homicide and street violence in violent urban conflicts, which has experienced a dramatic increase in the number of cases in the last few years in Indian cities.

5. Digital Forensics

As this time digital technologies are pervasive in the different spheres of human activity, digital

forensics implied an absolutely necessary instrument also in the field of criminal investigation. This domain includes material extraction and characterization of materials from digital devices (i.e., computers, smart phone, smart watch and other electronic devices). Evidence generated via social media, electronic mails, and different applications is valuable as the information it generates can be used to gain insights into whereabouts and activities of a suspect both before and after the committed crime. In India, the law is sometimes being revised in order to stop digital depredation and for safe collection and analysis of digital evidence.

6. Toxicology

Toxicological assay is used to detect chemicals, drugs, and poisons in biological specimen. For the forensic applications, this kind of evidence is of interest in the illegal drug overdose, suspected poisoning, as well as drunk driving (hit and run) cases. Medical and forensic toxicologists collaborate to explain the results, and to draw inferences from the relationship between the ingested substance and the crime.

7. Document Examination

Forensic document examination is a significant tool for document authenticity, handwriting specimen authentication, and the examination of authenticity of documents for authenticity or fraud. In a country such as India, where there is a huge number of official records, there is a field in forensic science that can be used to settle disputes in the areas of fraud and identity theft.

8. Forensic Anthropology and Odontology

Under very severe degenerative or calcified states, for example, with an anomalous bone appearance, the forensic anthropologists can consign an opinion for identification on the basis of a bone study and other morphology as described by the authors. Specifically forensic odontology with some particular application in the identification process, and in fact with some particular application in the data identification process together with the identification process, can also be utilized to information for

identification from the data of dental cardiology. Both are irreplaceable in scenarios of mass death/abnormal bodies.

As the forensic evidences are multidirectional in nature, the Indian criminal justice system is not only supporting the interrogation of the candidates to the investigation process but also supporting the process of legal proceedings. All types of forensic evidence have a major implication in the relationship between a suspect and a crime scene, as well as the role of the scientific evidence used in the forensics, in the exercise of truth and of justice. As India becomes ever more committed to the use of advanced forensic technologies and techniques, it is equally important to consider the ethical and legal structures that will govern their application, both to give justice in the criminal court" and to protect the rights of any person affected in criminal proceedings.

LEGAL FRAMEWORK GOVERNING FORENSIC EVIDENCE

The use of forensic evidence in the Indian legal system is, indeed, supported by a solid legal and regulatory framework, consisting of statutes, rules, and judicial pronouncements. In forensic science there is a significant role in criminal investigations and prosecutions because, not only may it provide scientifically derived evidence upon which judicial assertions can be based or be used to rebut assertions, but also/and because it can also provide evidence for factual conclusions regarding the application of forensic tests (McClellan, 2016). The principal enactments which provide the admissible and evidentiary value of evidence in the forensic field are Indian Evidence Act, 1872, Code of Criminal Procedure, 1973 and Criminal Procedure Code, 1973.

The Indian Evidence Act, specifically Sections 45 and 59, are critical to the determination of whether evidence of pathology as expert evidence in the shape of forensic evidence may be admitted. Section 45 lays down the scope of the expert's knowledge that can be established

for the report of the opinions of these witnesses on the technical, i.e., DNA, fingerprints, ballistics and other kind of forensic technical examination, in order to be dealt with by the court. Section 59 indications of the admissibility of oral evidence spoken and written is the balancing decision to the evidence to be disproved of testimony given by a specialist, which can be of a special relevance.

Moreover, the Criminal Procedure Code has directed the process for the collection of the same and its production before the court of Criminal evidence. Section 166 highlights the need to acquire evidence in a judicially supervised and controlled manifestation combined with forensic evidence in order to permit legally valid procedures under 166. The trend for forensic science that is calling for pivotal discussion by the professional forensic community of the world as well, which requires giving a look to instructions provided by the National Forensic Sciences University and other topnotch forensic laboratories, which has a standard of evidence collection, preservation and analysis, for the forensic work to be valid.

Judicial precedents also redefine the Indian forensic landscape. Landmark cases, like State of U.P. V .Rajesh Gautam⁹¹⁶, has presented the court's view of forensic evidence, highlighting the importance of adherence to protocol in both the collection and the analysis phases. By also further establishing that although the forensic evidence is of great interest, it must be corroborated by/and another evidence to afford it the appropriate juridical weight in order for a conviction to be reached.

Furthermore, this significant increase in the spatial extent of forensic technology is bound to lead to the development of, amongst other problems, new privacy, digital forensics and ethical questions about the use of this type of evidence. After latest amendments in legislation and the release of recommendations in the field of cyber forensics and digital evidence, now the

⁹¹⁶ State of U.P. v. Rajesh Gautam, A.I.R. 1991 S.C. 420

tunnel has been bridged, in order to tackle the new problems in the world of forensic science.

The legal control of forensic evidence in India is intricate and comprises a mixture of statutory, procedural and judicial control (ie) all designed to render the forensic evidence capable of being deployed within the efficiency of the criminal justice system. Due to the technological advancements in the field of forensic science, the obligation lies on the government of India to bring it into action and streamline the law and its enforcement. Not only will this adaptation improve the confidence and validity of forensic evidence, but it must continue to support the principles of justice in a constantly changing and digital era. Hence, the importance of continuing education, standardization of procedure, and ethical practice cannot be overemphasized in earning a positive image of forensic science as a critical tool of criminal law in India.

SIGNIFICANCE OF FORENSIC EVIDENCE IN CRIMINAL INVESTIGATION

It is through forensic evidence that conduct within actual criminal inquiries is viewed to serve at the very heart of the fair trial right and maintenance of the rule of law. Indian justice system despite the problem of backlogs and corruption at the same time has to be pushed towards the use of proofs and forensic evidence as an objective and scientific solution as an alternative approach to the conventional investigative methods for crime solution. Particularly, forensic evidence has the ability to resolve the link between the crime location and the victim and the potential attacker, and this evidence is of perhaps the most critical value in obtaining a great volume of evidence at the prosecution of the case.

For instance, DNA, fingerprints, bloodstain and ballistics analysis can provide irrefutable links on which other kinds of evidence cannot contribute. In certain sexual assault cases, e.g., crime scene DNA, its recovery of the perpetrator has a high likelihood of being correct with the

aim of minimizing a wrong apprehension and conviction. Furthermore, the advent of modern forensic technologies (i.e, digital forensics, toxicology, and forensic anthropology) significantly enhances the investigating ability.

Moreover, the Indian courts also largely accorded more weightage to forensic evidence in litigation. Landmark rulings have established criteria by which the lack of forensic testing resulted in a gap in the integrity of both the investigation and the supporting evidence. The advent of forensic evidence strengthens prosecution's case simply to show it so that it can also be evidence for law enforcement, for there is scarcely any room for running from the application of science to crime in forensic investigation.

1. Linking Suspects to Crime Scenes

Forensic evidence is the main tool used to link an offender to a crime scene, among others. By means of various ways, forensic data can facilitate this, such as DNA profiling, fingerprint matching, ballistics, and digital forensics. Forensic evidence can offer irrefutable proof of association to help secure a conviction.

For example, during the case of Nirbhaya (2012)⁹¹⁷, the forensic investigations played an important role because of the employment of DNA evidence for linking the accused to the Crime scene. The residue from the victim's body fluids was adequately described and DNA was compared with the DNA of the accused man, which was the basis of the prosecution's charge. The protracted work of forensic practitioners contributed to successfully achieving justice in nationally publicized litigation, while also highlighting the utility of forensic services as a process for achieving convictions.

Further, in State of Karnataka v. S. Suresh (2013)⁹¹⁸, the Supreme Court accepted the traffic of (forensic) evidence in the form of accounts of the movement of the accused at the scene of crime. As the court has also pointed out, the

⁹¹⁷ Mukesh & Anr. v. State for NCT of Delhi, (2017) 6 S.C.C. 1

⁹¹⁸ State of Karnataka v. S. Suresh, A.I.R. 2013 S.C. 2148

analysis on the blood and hairs sample addressed at crime scene, which is of absolutely great utility, has been extremely important for proving that the crime has been carried out by the respondent was also of great usefulness to develop the proceeding. In this example it is shown that forensic evidence may be a decisive factor in the evidence for the (un)guilt of indicted suspects.

2. Establishing Modus Operandi

Forensic evidence has been used too to describe how offenders may have been taking advantage of victims, and this can have an extremely useful secondary deciphering to chain, not only by ordering crime, but also by identifying how and where to source and use in the continuing series of crimes that are still loose. Recognizing of shared features of crime scenes and associated forensic evidence from investigations of crime scenes allows law enforcement to derive clinically relevant information about the offender's behavior and process.

For instance, in this case, forensic evidence was employed to reconstruct the modus operandi of a serial rapist in *State of Maharashtra v. Sukh Ram (1992)*⁹¹⁹. The forensic unit also found these same recurrent patterns in the forensic evidence collected at crime scenes nationwide, which in turn led to a demonstrably homogeneous modus operandi. Not only did this connection allow the defendant to be considered a perpetrator of some of the offences, the information released triggered an examination of a broader group of pending cases to have opened. Here, however, the forensic evidence served to establish the required connections between, if not explaining, what seemed like a discrepancy between a sequence of events (i.e., the booking and/or trial of a serial perpetrator).

More particularly, by applying forensic techniques in the *Shivraj Patil v. State of Maharashtra (2017)*⁹²⁰ case, the application of

ballistic matching technique not only allowed the role to identify the weapon used in the mass sequence of killings. For submitting the application of ballistic properties of the tool of the defendant as an illustration of what can be done for the possibility of forensic evidence to debunk the frame in which one considered the crime to have actually taken place, the forensic laboratory of the accused submitted.

Typically, forensic evidence serves as the foundation around which a suspect's link to a crime scene as well as modus operandi can be inferred. But ways in which its potential can be used to the advantage of forensic purposes also make it a tool useful to law enforcement to conduct an efficient, effective, and conclusive investigation, but also for the purpose of protecting the apparatus of justice, that is, imprisoning the guilty while leaving the innocent unprotected and vulnerable. Forensic analysis has been instrumental in some of the historical pronouncements of the Indian judiciary, it is the heart of a paradigm shift in the criminal justice process.

However, for whom is forensic evidence in criminal cases of guilty much more useful than any potential benefit, its value lies much more greatly in the exoneration of innocent people than could be derived from an insight into the sentence of guilty. Advances in forensic modalities have generated interest in revisiting past cases with the lens of current scientific advances. With this approach, it is possible to uncover false beliefs and maintain the legitimacy of the criminal justice system.

Forensic evidence plays a vital role in criminal investigations in India. It represents the deepest integration between science and law at the service of a safer, more just, and equitable legal system. As the Indian investigative network continues to modernise, forensic science must be given the necessary manpower and the recognition that it deserves. Enhancement of well-equipped forensic laboratories, staff education, and standard operational procedures number related to forensic

⁹¹⁹ *State of Maharashtra v. Sukh Ram*, A.I.R. 1992 S.C. 1356

⁹²⁰ *Shivraj Patil v. State of Maharashtra*, A.I.R. 2017 S.C. 981

evidence collection and analysis will assist in both the efficacy of forensic evidence in pursuit of crime, and in the efficacy of justice in being, rather than merely sought, but obtained. The point of convergence between the science of forensic evidence and legal structures offers the prospect of a fairer justice system wherein the hidden reality can be brought to light by the thoughtful use of science to support criminal law.

A few of the high profile cases in India highlight the necessity of forensic evidence, particularly when the facts are disputed and public interest is considerable. Examples of the forensic evidence application in investigations like the Aarushi Talwar double murder case⁹²¹, the Tarde Jessica Lal murder case⁹²² depict the situations in which forensic evidence played a very important role in the investigation, however not without difficulties. These examples also show deficiencies and errors of forensic analysis, such as mishandling evidence, forensic delays of the analysis, or the absence of modern forensic facilities, which in turn could slow down the wheels of justice.

For example, in the Aarushi Talwar case, discrepancies in forensic evidence and its readings as well as different examiners' readings and interpretations created a lot of public controversy and impacted the ultimate outcome. In this case, it illustrates the potential of forensic evidence to be both persuasive and erroneous if not applied with accuracy and control. Also, in the Nirbhaya gang rape case, forensic evidence such as DNA analysis also helped corroborate eyewitness accounts, and timebound finality of the trial, thereby illustrating the power of wellconducted forensic analysis to deliver justice in matters of public interest.

STANDARD OF ADMISSIBILITY

The admissibility of forensic evidence in Indian courts is a critical aspect that determines its impact on judicial decisions. It is the final arbiter of forensic evidence adjudication in the courtroom and persuasiveness of forensic evidence in the judicial process.

▪ The Four Aspects of Admissibility in Indian Law

Indian courts assess the admissibility of forensic evidence through relevance, legality, reliability, and genuineness. These criteria are used to help assure the tension between the scientific objectivity and the procedural fairness: .

1. Relevance:

There should, ideally, be a strong link between both the forensic evidence and case and either directly or indirectly relate to the crime, perpetrator, or victim. In judicial proceedings the weighting of evidence to support or refute the prosecution of elements of the offense, i.e., motive, identity and method of commission, is assessed.

One such example is forensic evidence, which can provide a presumptive perpetrator identification within the crime scene directly (e.g., DNA, fingerprint or ballistic comparison analysis), which is commonly regarded as a circumstantial piece of evidence (i.e., the most crucial). Evidence that does not directly establish a connection may be excluded.

2. Legality:

Evidence collection should be done keeping in view the ongoing legal proceeding as well as the safeguard to the human rights, as prescribed in Indian Evidence Act, 1872 and the provisions of Code of Criminal Procedure, 1973.

But enforcement of these legal precedents depends on compliance with the law of search and seizure and the right to silence guaranteed through Article 20(3) of the Indian Constitution. [For example], DNA sample collection in the absence of consent and wiretaps can serve as

⁹²¹ Rajesh Talwar & Anr. v. C.B.I. & Anr., (2013) 82 A.C.C. 137 (Allahabad High Court)

⁹²² Manu Sharma v. State (NCT of Delhi), (2010) 6 S.C.C. 1.

a basis for inadmissibility, for example, when judges struck illegally gathered evidence.

3. Reliability:

The techniques applied to forensic analysis must be scientifically validated and peer reviewed in the scientific community. Results such as, e.g., "DNA analysis" or "comparison of fingerprints" have become increasingly established for its scientific rigor and good error rate.

The criterion of reliability penalizes methods of the form that would be most liable to cause a false result while appearing plausibly or even promisingly. Courts require procedures, error rates, and peer review validation of forensic techniques to achieve valid results.

4. Credibility:

The forensic expert's qualifications and objectivity are essential. That is assumed, that an adequate expert has the appropriate training, appropriate required standard and an unbiased opinion. The scientist's task is to present to the jury a clear idea of what technical science is, and present to the court, rather than to instruct the jury in what to do on the evidence (or evidence that might or might not be researchable)," etc.

Forensic practitioners must remain nonpartisan, and for example, sup posing evidence of bias or a lack of qualification can erode credibility of such evidence. Credibility to experts is given by the courts a very heavy weight, because interpretation of forensic evidence is adjacent to having an expert opinion 1.

▪ Establishing the Chain of Custody

It refers to a jurisdictional process that ensures that the evidence is properly documented and preserved from the moment it is taken at the crime scene until it is applied before the court. Due to its unbelievable cyclic behaviour the proof is shown to remain uncorrupted, degraded or falsified, and therefore the integrity of the proof must be preserved. In the event of any break/detachments in the chain of custody of the matter, the matter shall be diverted to the

court to review the evidence and its validity and, as such, the validity of the evidence will be ruled out.

In particular, forensic evidence, i.e., bloodstains or gunshot residues, needs to be appropriately logged for every step of the handling chain. Tribunals can call for testimony from every person who has touched the exhibits to preserve the purity and to reject allegations of contamination or bad handling.

▪ Accuracy, Precision, and Reliability of Forensic Methods

Indian courts, not only requiring, but requiring the technical validity and reliability of techniques applied to very precise and accurate levels of technical precision and accuracy for the service of the justice system's need for dependable and predictable results.

- a) Accuracy: That, to the greatest extent, the forensic output matches the true values (i.e., correctly identifying the right subject by DNA). DNA profiling is one of the most exciting application because of its high level of accuracy and its well explained history in the Indian judiciary.
- b) Precision: Reproducibility of the experimental findings, and high reproducibility across a large number of analyses defines accuracy. Forensic professions, which deliver consistent and reproducible outputs, e.g., fingerprint classification, "usually" meet the requirements for court admissibility.
- c) Reliability: The focus of this standard lies in the importance, characterization of, and forensic methodology with characterized error rates. Even with the high probability that DNA evidence will be observed, emerging technologies such as digital forensics may still be contested. The results of the new techniques could be poorly accepted in the court if their validation, peer review, and error rate data are not available.

For example, digital forensic data from mobile phones or electronic data is from time to time

challenged in respect of the reliability of the method and the possibility of technical failures. Although such methods are increasingly being scientifically accepted and systematized, such evidence is met with much resistance from the courts of law.

▪ Forensic Evidence's Impact on Court Decisions

The results of a case can be significantly impacted by forensic evidence. DNA evidence proved crucial in convicting the guilty in a historic case, demonstrating the weight that such evidence may have. As seen in *Ram Chander v. State of Haryana*⁹²³, when the Supreme Court ruled that the forensic findings needed to be supported by further evidence, the judiciary does exercise caution, though.

▪ Indian law's requirements for expert witnesses

Forensic evidence presenters need to fulfill specific requirements:

Qualifications: In the appropriate field, they must possess certain knowledge, skills, experience, training, or education.

Impartiality: They ought to offer objective judgments supported by the data.

Relevance and Reliability: Their testimony needs to be scientifically sound and relevant to the facts at hand.

Furthermore, landmark rulings frequently have an impact on the reliability and relevance standards for scientific evidence. The Supreme Court noted in *State of Haryana vs. Bhagirath*⁹²⁴ that, as long as expert testimony satisfies the established standards of credibility, scientific advancements need a progressive approach to its adoption.

The requirements for admissibility make sure that forensic evidence advances the search for the truth without jeopardizing the accused's rights or the fairness of the legal system. The practical implementation of these standards

and their practical ramifications will be covered in detail in the next section.

CHALLENGES FACED IN UTILIZATION

In order to understand not only the possible but also the actual constraints, from the point of view of the actual scope of application of forensic evidence in Indian criminal justice system, an in-depth comparison of the same "Indian context" is necessary. Despite the possibilities that forensic science can offer in the context of optimizing legal procedures, there are several barriers in the way of its effectiveness and reliability in India. Possible complications may be aggregated at the macro scale, within the infrastructural, procedural, legal and operational issues.

1. Deficiencies Of Infrastructure

In India labs are constrained by lack of institutions to meet the increasing demand of forensic investigations due to the growing number of cases. This backlog has resulted from the case load gap in forensic work and is leading to a delay in criminal investigations and trials.

Outdated Technology: Forensics laboratories are burdened with the stale technology and with scarce budgets, and the range of their modern analyses is however very limited. This technological gap could threaten the plausibility and acceptability of forensic evidence.

Shortage of Trained Forensic Experts: There is a lack of trained and certified forensic personnel in India. Consequently, forensic professionals are often required to perform such work under immense pressure and with the risk of inaccuracy due to overwork, which may lead to volatile quality of forensic evidence created.

2. Procedural and Legal Challenges

Inconsistent Chain of Custody: Consistency of the chain of custody from crime scene to the court room that preserves the integrity of forensic evidence are essential. Meanwhile, errors in information processing, storage or

⁹²³ *Ram Chander v. State of Haryana*, A.I.R. 1981 S.C. 1036.

⁹²⁴ *State of Haryana v. Bhagirath*, (1999) 5 S.C.C. 96.

documentation can cast doubt on the reliability of evidence. Errors that are minute can result in exclusion of evidence in the courtroom.

Forensic services are historically concentrated in urban areas and thus, rural and small jurisdictions may lose out in terms of service access. This mismatch results in a difference in the quality and in how many items are searched for across sites.

Delays in Forensic Reporting: However, it is not uncommon for procedural slowing down and forensic reports to be delayed for months, or even years, due to backlogs and inefficiencies. These delays have a consequence not only in terms of the duration of the litigation, but also in terms of the duration of the functions that they will bear in the end part of the delivery of justice.

3. Judicial Challenges and Acceptance Issues
While DNA fingerprint analysis has been both widely accepted and generally accepted, some forensic techniques might even be potentially controversial scientifically, in terms of the method employed as a whole, and the use of retrospective, novel/experimental methods may be questioned in court, especially where novel/unproven evidence is considered. Nonstandard use of forensic analysis by judges may be a result of the absence of previous precedent for its use, rendering the evidence unreliable with resulting inadmissibility, lack of weight, and thus significance.

Forensic evidence is generally viewed by the Indian legal system as a secondary and not the decisive evidence. It is also an inescapable conclusion that forensic evidence will not be enough to secure a conviction even if it is unsupported by any type of evidence or by evidence of fact witnesses. As a result, high quality forensic evidence may be "left behind" at trial.

4. Legal and Regulatory Constraints

Limited Standardization of Forensic Procedures:
Mismatch of standardized norm and of rules and regulations performed by the forensic laboratory among one another and to forensic

laboratories/labs in India may give rise to discrepancy in analysis and heterogeneous quality of forensic report. Forensic procedures may differ across different laboratories, and this in turn, impedes the reproducibility of evidence, and particularly when complex analyses such as toxicology or ballistic tests are undertaken.

Many of these advanced approaches (e.g., brain mapping, narcoanalysis, polygraph test) are limited at best and have, at least, proven to engender anxieties of abuse of the right of an individual and, perhaps, still of the right of the profession of lawyers. Landmark cases, e.g., *Selvi v. State of Karnataka* (2010)⁹²⁵, show that such methods are acceptable in context only with an exception, that they still have to be addressed in the way to allow the rights of the accused to be vindicated.

5. Operational Challenges in Evidence Collection and Handling

Challenges in Crime Scene Management:
In crime scene management, misconduct, such as lack of sealing, documentation, or evidence preservation, may lead to contamination or evidence loss forensic. In India, police personnel are, for the most part, not equipped with forensic technique and are likely to mishandle the same at the time of their collection.

Close working relationships between police forces and forensic scientists are of vital importance in forensic science. There is still the scenario that communication failures or different interests (agenda) between law enforcement and other agencies can stop the full caramelization of forensic evidence in cases and, as result, its subsequent prosecution.

6. Public Perception and Media Influence

In general, the official attention is often given to a prominent case in India, which exerts higher strain on the forensic laboratory, and, as a consequence, it has a ripple effect on the public image of the importance of forensic evidence. All of this can sometimes result in inadequate or

⁹²⁵ *Selvi v. S Sushil Sharma v. State* (NCT of Delhi), (2007) 6 S.C.C

hurried forensic processes, particularly in highly publicised cases.

In the media depiction of forensic sciences, simplification and sensationalism have, in fact, created public expectations that are not entirely congruent with the reality of forensic analysis in India. There is a risk that this "CSI effect" leads to an unrealistic expectation in terms of forensic skill (and timescale) that is not attainable by forensic practitioners or the criminal justice system.

There have been instances where the misapplication of forensic evidence led to miscarriages of justice, for eg, The Naina Sahn Tandoor Murder Case⁹²⁶: The case was complicated by the destruction of evidence. However, forensic methods managed to piece together the evidence, leading to a conviction.

These issues have brought to light the issues that arise when forensic evidence is introduced into the Indian criminal justice process. While forensic science has an enormous potential to improve the accuracy and objectivity of criminal investigations, it is, nevertheless, crucially important to overcome the deficits that are limiting the performance and the credibility of the forensic science. Options can consist of the delivery of forensic facilities, the training of legal/law enforcement personnel and the implementation of already clearly defined and standardized procedures for forensic analysis. It is only when these problems are addressed that the Indian legal system can be brought to bear effectively to deploy forensic evidence for representing justice, and that the full potential of it for criminal justice purposes can be achieved.

Conclusion

With the establishment of forensic evidence as a vital tool for the Indian criminal justice system, the world of scientific evidence is brought to the realm of the law and contributes to the process of fact identification, detection of criminal

activities, and pursuit of justice. This article has investigated the complex function of forensic evidence in India, ranging from the legal and judicial guidelines and jurisprudence to its limitations and directions of change. Through case law, statutes, and (procedural) rules, Indian courts have developed over time a balanced entity that strives to achieve the highest possible level of the usability of forensic evidence at the cost of the respect for the constitutional, ethical, and procedural safeguards.

On the basis of landmark court decisions one can infer that forensic evidence, whatever its strength, is commonly, through forensic evidence, supplementary to other evidence. In India, the forensic traditions of the judiciaries have highlighted the need to validate forensic evidence by alternative means and to impose stringent limits of admissibility, particularly in invasive modalities. Additionally, significant examples, such as Selvi v. State of Karnataka and Ramchandra Reddy v. State of Maharashtra⁹²⁷, have shown the vulnerability related to the balancing of establishment of forensic tools and fundamental rights and validated the notion that the drive for truth cannot be at the expense of a human being's rights.

Simultaneously, given the paucity of manpower, procedural errors and the vulnerability to forensic evidence misinterpretation and its abuse in involuntary convicting of an innocent person the paper then summarizes the enormous obstacles in the field. These challenges can be best tackled through redevelopments that are in the very nature of the forensic infrastructure of India, broadening the scope for forensic training within law enforcement, and the preparation of guidelines on handling of forensic evidence. As the principles and practice of forensic science evolve in parallel with developments in DNA sequencing, digital forensic science, and so on, there will be a need for increasingly precise and

⁹²⁶ Sushil Sharma v. State (NCT of Delhi), (2007) 6 S.C.C. 1

⁹²⁷ Ramchandra Reddy & Ors. v. State of Maharashtra, (2004) 2 S.C.C. 422

robust methods for criminal investigations into the future.

In conclusion, forensic evidence has reshaped criminal justice in India by enhancing transparency, objectivity, and accuracy in legal proceedings. However, if the impact is to be the transformative force it could be, India has to address the issues of the now, and to a justice system that can invoke the fruits of the sciences, all without overstepping the bounds of the rule of law that must protect both the quest for justice and the right to liberty.

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