
EXAMINING INSTITUTIONAL LOOPHOLES IN THE ADDUCING OF FORENSIC EVIDENCE: A CRITICAL LEGAL ANALYSIS

Sayana Johnson, LL.M., Bharata Mata School of Legal Studies, Aluva, Kerala, India

ABSTRACT

Forensic evidence plays an important role in the administration of criminal justice by assisting investigating agencies and courts in establishing facts through scientific methods. The effective use of such evidence depends upon its proper collection, preservation, examination and presentation before the court. However, institutional deficiencies at various stages of the forensic process may affect the reliability, integrity and evidentiary value of forensic material. This article critically examines the institutional loopholes involved in the adducing of forensic evidence within the criminal justice system. It focuses on deficiencies relating to the collection and preservation of forensic material, improper packaging, sealing and labelling, delays in forensic examination, inadequate forensic infrastructure and weaknesses in maintaining the chain of custody. The study also examines the risks of contamination and human error during the handling, transportation, examination and interpretation of forensic evidence. Particular attention is given to the responsibilities of investigating officers, forensic laboratories and other institutional stakeholders in maintaining the integrity and reliability of forensic evidence throughout the investigative and judicial process. The article further considers the role of courts in assessing forensic evidence and the role of the defence in challenging its reliability where procedural safeguards have not been properly followed. By adopting a doctrinal and analytical approach, the study identifies the major institutional gaps that may undermine the effective use of forensic evidence in criminal proceedings. It concludes by suggesting measures to strengthen forensic infrastructure, professional training, procedural safeguards, quality control mechanisms and institutional accountability to ensure the reliable and effective use of forensic evidence in the administration of criminal justice.

Keywords: Forensic Evidence; Institutional Loopholes; Chain of Custody.

1. INTRODUCTION

Forensic science has emerged as one of the most indispensable components of the modern criminal justice system. With the rapid advancement of science and technology, the investigation of crimes has gradually shifted from dependence on confessions and eyewitness testimony to reliance on objective scientific methods. The application of forensic science enables investigators and courts to reconstruct criminal events, identify offenders, establish the identity of victims, and evaluate physical evidence with greater precision. Scientific techniques such as DNA profiling, fingerprint examination, ballistic analysis, toxicological testing, digital forensics, and forensic pathology have significantly enhanced the accuracy and reliability of criminal investigations.¹ Consequently, forensic science has become an essential instrument in ensuring that justice is administered on the basis of credible and scientifically verifiable evidence rather than conjecture or suspicion.²

In the administration of criminal justice, forensic evidence performs a dual function. On the one hand, it assists in establishing the guilt of offenders through objective scientific analysis. On the other hand, it protects innocent individuals from wrongful prosecution by eliminating uncertainty and reducing the possibility of mistaken identity or false implication. Courts increasingly recognize that scientific evidence, when properly collected, preserved, examined, and presented, possesses considerable evidentiary value and often provides greater reliability than purely oral testimony. Consequently, forensic science has become an indispensable aid to investigating agencies, prosecutors, defence counsel, and the judiciary in the pursuit of justice.

The growing dependence on forensic science has also resulted in a corresponding increase in institutional responsibilities. The effective use of forensic evidence requires close coordination among investigating officers, forensic science laboratories, medical experts, prosecutors, and judicial authorities. Every stage, beginning with the identification and collection of evidence at the crime scene and continuing through preservation, laboratory examination, documentation, and presentation before the court, must be carried out in accordance with established scientific and legal standards.³ Even a minor lapse during any of these stages may compromise the evidentiary value of the material and adversely affect the outcome of a

¹ K.S. Narayan Reddy and O.P. Murty, *The Essentials of Forensic Medicine and Toxicology* (35th edn., Jaypee Brothers Medical Publishers, New Delhi, 2017)

² Bharatiya Sakshya Adhiniyam, 2023, s. 39.

³ Bharatiya Nagarik Suraksha Sanhita, 2023, s. 176.

criminal trial.

Despite the increasing significance of forensic science, the Indian criminal justice system continues to encounter several institutional challenges in effectively adducing forensic evidence before courts. Delays in forwarding exhibits to forensic laboratories, shortage of trained forensic experts, inadequate laboratory infrastructure, improper collection and preservation of evidence, contamination of exhibits, breaks in the chain of custody, and lack of coordination among investigating agencies remain persistent concerns.⁴ These deficiencies frequently diminish the reliability of scientific evidence and may result in delayed trials, acquittals, or even wrongful convictions. Such shortcomings undermine public confidence in both forensic institutions and the criminal justice system.

1.1 Meaning and Concept of Forensic Science

The term “forensic” is derived from the Latin word *forensis*, which means “of or before the forum.” In ancient Rome, the forum was a public place where legal disputes were heard and justice was administered. Consequently, the term “forensic” came to be associated with matters relating to law and the administration of justice. In modern times, forensic science refers to the application of scientific knowledge and techniques to investigate crimes and assist courts in the administration of justice.⁵

Forensic science may be defined as the application of scientific principles and methods to identify, collect, preserve, examine, analyse, and interpret evidence for use in legal proceedings. It combines various branches of science, including biology, chemistry, physics, medicine, toxicology, and digital technology, to establish facts relevant to criminal and civil cases.⁶ The primary objective of forensic science is to discover the truth through scientific examination and provide reliable evidence that assists courts in reaching fair and just decisions.

The scope of forensic science extends from crime scene investigation to the presentation of expert evidence before the court. It includes the examination of fingerprints, DNA, bloodstains, firearms, questioned documents, toxic substances, digital devices, and other forms of physical

⁴ National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (National Academies Press, Washington, D.C., 2009)

⁵ B.R. Sharma, *Forensic Science in Criminal Investigation and Trials* (6th edn., Universal Law Publishing Co. Pvt. Ltd., New Delhi, 2019)

⁶ Richard Saferstein, *Criminalistics: An Introduction to Forensic Science* (13th edn., Pearson Education, New York, 2020)

evidence.⁷ Proper collection, preservation, and scientific analysis of such evidence play a crucial role in identifying offenders, linking suspects to crime scenes, reconstructing events, and, in appropriate cases, establishing the innocence of wrongly accused persons.

In the modern criminal justice system, forensic science has become an indispensable investigative tool. Unlike oral evidence, which may be affected by memory lapses or personal bias, scientific evidence is generally regarded as objective and reliable when collected and analysed according to accepted procedures. However, the accuracy of forensic evidence depends upon proper investigation, qualified experts, adequate laboratory facilities, and strict adherence to scientific standards. Therefore, forensic science not only supports criminal investigations but also strengthens the administration of justice by ensuring that judicial decisions are based on credible and scientifically tested evidence.

1.2 Evolution and Historical Development of Forensic Science

The history of forensic science dates back to ancient civilizations, where rudimentary scientific methods were employed to detect crimes and resolve legal disputes. Ancient Egyptians used medical knowledge to examine injuries and causes of death, while the Romans recognised the significance of physical evidence in criminal proceedings. One of the earliest recorded works on forensic investigation was the Chinese text *The Washing Away of Wrongs* (1248 AD) by Song Ci, which described methods for investigating suspicious deaths and identifying causes of homicide.⁸

The scientific development of forensic science gained momentum during the nineteenth and twentieth centuries. Advances in medicine, chemistry, biology, and physics led to the emergence of specialised forensic disciplines such as fingerprint identification, forensic toxicology, ballistics, questioned document examination, and later DNA profiling. The discovery of fingerprints as a unique means of personal identification by Sir Francis Galton and the introduction of DNA profiling by Sir Alec Jeffreys in 1984 revolutionised criminal investigations by providing highly reliable methods of identifying individuals.⁹

⁷ Max M. Houck and Jay A. Siegel, *Fundamentals of Forensic Science* (4th edn., Academic Press, London, 2019)

⁸ Song Ci, *The Washing Away of Wrongs: Forensic Medicine in Thirteenth-Century China*, translated by Brian E. McKnight (University of Michigan Press, 198).

⁹ Sir Alec J. Jeffreys, Victoria Wilson and S.L. Thein, "Individual-specific 'Fingerprint's of Human DNA", (1985)

In India, forensic science has developed significantly since independence. The establishment of forensic science laboratories, medico-legal departments, and specialised investigative agencies has strengthened the scientific investigation of crimes. Today, forensic experts assist investigating agencies in analysing biological samples, firearms, fingerprints, digital devices, narcotic substances, and other forms of physical evidence. Technological advancements have further expanded the scope of forensic science to include cyber forensics, digital evidence analysis, and artificial intelligence-based investigative techniques.¹⁰

1.3 Importance of Forensic Science in the Criminal Justice System

Forensic science plays a pivotal role in the modern criminal justice system by ensuring that criminal investigations are based on scientific analysis rather than mere suspicion or conjecture.¹¹ It provides objective and reliable evidence that assists investigating agencies in identifying offenders, establishing the identity of victims, reconstructing the sequence of events, and determining the cause and manner of death. Through scientific examination of physical evidence, forensic science enhances the accuracy and credibility of criminal investigations.¹²

One of the most significant contributions of forensic science is its ability to establish a direct link between the accused, the victim, and the crime scene. Techniques such as DNA profiling, fingerprint examination, ballistic analysis, toxicological testing, and digital forensic analysis enable investigators to collect and analyse evidence with a high degree of precision. Such evidence often corroborates oral testimony and helps courts arrive at well-reasoned and impartial decisions.

Forensic science also acts as a safeguard against wrongful convictions. Scientific evidence has the potential not only to establish the guilt of an offender but also to exonerate innocent persons who have been falsely implicated. In this way, it promotes the fundamental principles of fairness, due process, and the rule of law. The increasing reliance on forensic evidence reflects the transformation of the criminal justice system from confession-based investigations to

¹⁰ National Forensic Sciences University, Annual Report 2023–2024 (Ministry of Home Affairs, Government of India).

¹¹ Barry A.J. Fisher, *Techniques of Crime Scene Investigation* (8th edn., CRC Press, Boca Raton, 2013)

¹² Suzanne Bell, *Forensic Chemistry* (2nd edn., Pearson Education Inc., Boston, 2013)

evidence-based investigations.¹³

1.4 Role of Forensic Science in the Administration of Justice

Forensic science serves as an indispensable aid in the administration of justice by providing scientific assistance at every stage of the criminal justice process. From the investigation of a crime to the final adjudication of a case, forensic evidence enables investigating agencies and courts to determine facts with greater accuracy and objectivity. The use of scientific methods reduces dependence on confessions and unreliable eyewitness accounts, thereby ensuring that judicial decisions are based on credible and verifiable evidence.

During the investigation of a crime, forensic experts assist in the identification, collection, preservation, and examination of physical evidence recovered from the crime scene. Scientific analysis of fingerprints, DNA samples, bloodstains, firearms, questioned documents, toxic substances, and digital devices often helps establish the identity of the offender and reconstruct the sequence of events.¹⁴ Such evidence enables investigators to identify the actual perpetrator while protecting innocent individuals from false implication.

In judicial proceedings, forensic experts play an important role by presenting their findings before the court in the form of expert opinions. Their scientific analysis assists judges in appreciating complex technical evidence and determining the evidentiary value of the material produced before the court. When properly collected and analysed, forensic evidence enhances the fairness, transparency, and credibility of criminal trials.

However, the effectiveness of forensic science in the administration of justice depends upon efficient institutions, qualified experts, modern forensic laboratories, and strict adherence to scientific and legal procedures. Any deficiency in the collection, preservation, examination, or presentation of forensic evidence may adversely affect the outcome of a criminal trial. Therefore, strengthening forensic institutions and ensuring scientific integrity are essential for the effective administration of justice.¹⁵

¹³ United Nations Office on Drugs and Crime, *Crime Scene and Physical Evidence Awareness for Non-Forensic Personnel* (United Nations, New York, 2009)

¹⁴ Jay A. Siegel, *Forensic Science: The Basics* (3rd edn., CRC Press, Boca Raton, 2015)

¹⁵ Law Commission of India, 185th Report on Review of the Indian Evidence Act, 1872 (2003)

2. CONCEPT AND CLASSIFICATION OF FORENSIC EVIDENCE

Forensic evidence constitutes the foundation of scientific investigation in the modern criminal justice system. It refers to any material or information that is scientifically examined to establish facts relevant to a legal proceeding. Unlike ordinary evidence, forensic evidence is based on scientific principles and objective analysis, thereby enhancing the accuracy and reliability of criminal investigations. It assists investigating agencies in identifying offenders, establishing the identity of victims, reconstructing the sequence of events, and determining the cause and manner of an offence.

The significance of forensic evidence has increased considerably with the advancement of science and technology. Modern investigative techniques such as DNA profiling, fingerprint analysis, ballistic examination, toxicological testing, and digital forensic analysis have transformed the process of crime detection and prosecution. Scientific evidence not only supports oral and documentary evidence but also minimises the possibility of wrongful convictions by providing objective and verifiable findings.¹⁶ However, the evidentiary value of forensic evidence depends upon its proper collection, preservation, examination, and presentation before the court.¹⁷

2.1 Meaning of Forensic Evidence

Forensic evidence refers to any physical, biological, chemical, or digital material that is scientifically examined to establish facts relevant to a legal proceeding. It is collected from the crime scene, the victim, the accused, or any other relevant source and is analysed using recognised scientific methods. The purpose of forensic evidence is to assist investigating agencies and courts in discovering the truth and ensuring the fair administration of justice.

Unlike oral evidence, which may be affected by human error, bias, or memory lapses, forensic evidence is based on scientific examination and expert analysis.¹⁸ It provides objective and reliable information that helps establish the identity of offenders, connect a suspect with the crime scene, determine the cause of death, identify victims, and reconstruct the sequence of events. Consequently, forensic evidence has become one of the most valuable forms of

¹⁶ Manoj and Others v. State of Madhya Pradesh, (2023) 2 SCC 353.

¹⁷ Bharatiya Sakshya Adhiniyam, 2023, ss. 39 and 63; Bharatiya Nagarik Suraksha Sanhita, 2023, s. 176.

¹⁸ Batuk Lal, The Law of Evidence (22nd edn., Central Law Agency, Allahabad, 2022)

evidence in criminal investigations.¹⁹

Forensic evidence may include fingerprints, DNA samples, bloodstains, hair, fibres, firearms, bullets, toxic substances, questioned documents, electronic devices, and other trace materials. The evidentiary value of such material depends upon its proper collection, preservation, scientific examination, and presentation before the court.²⁰ Therefore, forensic evidence not only strengthens criminal investigations but also enhances the accuracy, fairness, and credibility of the criminal justice system.

2.2 Nature and Characteristics of Forensic Evidence

Forensic evidence is scientific, objective, and impartial in nature. It is derived from physical or digital materials that are examined using established scientific principles and techniques. Unlike evidence based solely on human perception or memory, forensic evidence is capable of being tested, verified, and, in many cases, independently reproduced. This scientific character makes it a highly reliable source of evidence in criminal investigations and judicial proceedings.

One of the most important characteristics of forensic evidence is its objectivity. It is not influenced by personal opinions, emotions, or external pressures but is based on scientific observation and analysis. Another significant feature is its corroborative value. Although forensic evidence may independently establish certain facts, it often supports and strengthens oral, documentary, and circumstantial evidence presented before the court.²¹ When different forms of evidence are consistent with forensic findings, the overall reliability of the prosecution or defence case is considerably enhanced.

The value of forensic evidence depends upon its authenticity and integrity. It must be collected, preserved, transported, and examined according to recognised scientific and legal procedures. Any contamination, tampering, or break in the chain of custody may reduce its evidentiary value and affect its admissibility before the court. Therefore, the reliability of forensic evidence is closely linked to the competence of investigating agencies, forensic experts, and the

¹⁹ *Tomaso Bruno v. State of Uttar Pradesh*, (2015) 7 SCC 178

²⁰ V.V. Pillay, *Textbook of Forensic Medicine and Toxicology* (19th edn., Paras Medical Publisher, Hyderabad, 2019)

²¹ Directorate of Forensic Science Services, Ministry of Home Affairs, Government of India, *Crime Scene Management: Standard Operating Procedures* (latest available edn.)

institutions responsible for handling such evidence.

2.3 Principles Governing Forensic Evidence

The effectiveness of forensic evidence depends upon certain well-established scientific and legal principles that ensure its reliability and evidentiary value. These principles govern the manner in which evidence is identified, collected, preserved, examined, and presented before the court. Strict adherence to these principles is essential for maintaining the integrity of forensic evidence throughout the investigation and trial.

One of the fundamental principles of forensic science is Locard's Exchange Principle, which states that every contact leaves a trace. According to this principle, whenever two objects or persons come into contact, there is a mutual transfer of material, such as fingerprints, hair, fibres, blood, soil, or other trace evidence. This principle forms the basis of modern forensic investigation, as it enables investigators to establish a connection between the crime scene, the victim, and the accused.²²

Another important principle is the preservation of evidence. Forensic evidence must be collected and preserved carefully to prevent contamination, deterioration, or loss. Equally important is the chain of custody, which refers to the continuous documentation of the possession, handling, transfer, and storage of evidence from the time it is collected until it is produced before the court.²³ A complete and unbroken chain of custody ensures the authenticity and admissibility of forensic evidence.

2.4 Classification of Forensic Evidence

Forensic evidence is classified into different categories based on its source, nature, and the scientific techniques used for its examination. Each category of forensic evidence serves a specific purpose in criminal investigation and assists investigating agencies in establishing facts relevant to the commission of an offence. Depending upon the nature of the crime, forensic experts examine biological, physical, chemical, or digital evidence to identify offenders, establish the identity of victims, reconstruct the sequence of events, and determine

²² Bureau of Police Research and Development, Ministry of Home Affairs, Government of India, Training Manual of Basic Course for Prison Officers (2022)

²³ Jehuda Hiss, Maya Freund and Tzipi Kahana, "The Forensic Expert Witness—An Issue of Competency", (2007) 168(2–3) Forensic Science International 89–94.

the cause of death or injury. With the advancement of science and technology, various forms of forensic evidence have gained significant evidentiary value and are increasingly relied upon by courts in the administration of justice. The major categories of forensic evidence are discussed below.

2.4.1 DNA Evidence

DNA (Deoxyribonucleic Acid) evidence is regarded as one of the most accurate and reliable forms of forensic evidence in modern criminal investigations. DNA is the hereditary material found in almost every cell of the human body, and except for identical twins, every individual possesses a unique DNA profile. This uniqueness enables forensic experts to identify individuals with a very high degree of scientific accuracy.²⁴

DNA samples may be collected from blood, saliva, semen, hair roots, bones, teeth, skin cells, and other biological materials recovered from the crime scene. These samples are scientifically analysed in forensic laboratories and compared with reference samples to establish the identity of a suspect or victim. The reliability of DNA evidence depends upon proper collection, preservation, maintenance of the chain of custody, and scientific examination by qualified experts.²⁵

2.4.2 Fingerprint Evidence

Fingerprint evidence is one of the oldest and most widely accepted forms of forensic evidence used in criminal investigations. A fingerprint consists of the unique patterns of ridges and valleys present on the fingers of every individual. Since no two persons, including identical twins, have identical fingerprints, fingerprint examination is regarded as a highly reliable method of personal identification.²⁶

Fingerprints may be recovered from objects, weapons, doors, windows, documents, or any surface that has been touched by an individual. Forensic experts develop and examine latent fingerprints using scientific techniques and compare them with the known fingerprints of

²⁴ John M. Butler, *Fundamentals of Forensic DNA Typing* (Academic Press, Burlington, 2010)

²⁵ Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad, Annual Report 2022–2023, chapter on DNA Profiling and Human Identification.

²⁶ David R. Ashbaugh, *Quantitative–Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology* (CRC Press, Boca Raton, 1999)

suspects.²⁷ When a match is established, fingerprint evidence can effectively connect an accused person with the crime scene or a particular object involved in the commission of the offence.

2.4.3 Ballistic Evidence

Ballistic evidence relates to the scientific examination of firearms, bullets, cartridge cases, gunshot residue, and other ammunition used in the commission of an offence. Forensic ballistics assists investigators in determining the type of firearm used, the distance from which the shot was fired, the direction of fire, and whether a particular bullet or cartridge was discharged from a specific weapon.²⁸ Such analysis is particularly significant in cases involving murder, attempted murder, armed robbery, terrorism, and encounter deaths.

The examination of ballistic evidence enables forensic experts to establish a connection between the firearm, the accused, and the crime scene. Modern forensic laboratories use advanced microscopic comparison techniques and other scientific methods to identify individual characteristics left on bullets and cartridge cases. Proper preservation of firearms and ammunition is essential to maintain their evidentiary value.

2.4.4 Toxicological Evidence

Toxicological evidence involves the scientific examination of poisonous substances, drugs, alcohol, chemicals, and other toxic materials found in the human body or at the crime scene. Forensic toxicology plays a crucial role in determining the cause of death, identifying cases of poisoning, drug overdose, intoxication, and offences involving narcotic substances.²⁹

Samples of blood, urine, stomach contents, tissues, and organs are analysed in forensic laboratories to detect the presence and concentration of toxic substances. The findings of toxicological analysis assist investigating agencies and courts in determining whether poisoning or intoxication contributed to the commission of an offence or the death of a person.

²⁷ Federal Bureau of Investigation, *The Science of Fingerprints: Classification and Uses* (US Department of Justice, Washington D.C., 1984).

²⁸ J.K. Modi, *A Textbook of Medical Jurisprudence and Toxicology* (27th edn., LexisNexis Butterworths Wadhwa, Nagpur, 2011), chapter on Firearms and Ballistics.

²⁹ Barry Levine (ed.), *Principles of Forensic Toxicology* (5th edn., Springer, Cham, 2020)

2.4.5 Biological Evidence

Biological evidence refers to evidence obtained from living organisms or biological materials such as blood, semen, saliva, hair, skin cells, bones, tissues, and body fluids. Such evidence is commonly encountered in cases of murder, sexual offences, assault, kidnapping, and disaster victim identification. Biological samples are scientifically examined to identify individuals, determine relationships, and reconstruct the circumstances surrounding the commission of an offence.

The reliability of biological evidence depends upon proper collection, preservation, storage, and laboratory examination. Any contamination or improper handling may adversely affect the accuracy of forensic findings. Therefore, investigating officers must strictly adhere to scientific protocols while dealing with biological evidence.³⁰

2.4.6 Digital and Cyber Forensic Evidence

The rapid growth of information technology has resulted in the increasing importance of digital and cyber forensic evidence. Digital forensic evidence includes information obtained from computers, mobile phones, hard disks, CCTV recordings, emails, social media platforms, cloud storage, and other electronic devices. Such evidence is extensively used in the investigation of cybercrimes, financial fraud, terrorism, identity theft, online harassment, and organised crime.³¹

Digital forensic experts employ specialised software and scientific techniques to recover deleted files, examine electronic records, trace online activities, and authenticate digital data. Since electronic evidence is susceptible to alteration, maintaining its integrity during collection and examination is of paramount importance.

2.4.7 Document and Handwriting Evidence

Document and handwriting evidence involve the scientific examination of signatures, handwriting, printed documents, typewritten materials, currency notes, passports, wills, contracts, and other disputed documents. Forensic document examiners analyse handwriting

³⁰ United Nations Office on Drugs and Crime (UNODC), Crime Scene and Physical Evidence Awareness for Non-Forensic Personnel (United Nations, New York, 2009)

³¹ Eoghan Casey, Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet (3rd edn., Academic Press, Burlington, 2011)

characteristics, ink, paper, printing methods, and alterations to determine the authenticity of a document or signature.³²

This type of forensic evidence is frequently used in cases involving forgery, cheating, fraud, counterfeiting, impersonation, and financial crimes. The opinion of handwriting experts assists courts in determining the genuineness of disputed writings, although such opinion is generally considered corroborative in nature.

3. ADDUCING FORENSIC EVIDENCE BEFORE COURTS

The process of adducing forensic evidence before courts involve the presentation of scientifically examined evidence in a legally acceptable manner to assist the court in determining facts in dispute.³³ Forensic evidence does not automatically become valuable merely because it is scientific in nature; it must pass through various stages, including collection, preservation, examination, and presentation, before it can be relied upon during judicial proceedings.

The successful use of forensic evidence depends upon coordination between investigating officers, forensic experts, prosecutors, and the judiciary.³⁴ Any defect at any stage of this process may affect the reliability and admissibility of the evidence. Therefore, proper procedures must be followed to ensure that scientific evidence maintains its authenticity and evidentiary value from the crime scene until its consideration by the court.

With the increasing importance of scientific investigation, courts have recognised the necessity of properly adducing forensic evidence in criminal trials.³⁵ The following sections examine the various stages involved in bringing forensic evidence before courts and the challenges associated with the process.

3.1 Meaning of Adducing Evidence

The term “adducing evidence” refers to the process of producing or presenting evidence before

³² Ordway Hilton, *Scientific Examination of Questioned Documents* (Revised edn., CRC Press, Boca Raton, 1982)

³³ K.N. Chandrasekharan Pillai, R.V. Kelkar’s *Criminal Procedure* (7th edn., Eastern Book Company, Lucknow, 2024)

³⁴ B.R. Sharma, *Forensic Science in Criminal Investigation and Trials* (5th edn., Universal Law Publishing, New Delhi, 2015)

³⁵ P.C. Dikshit, *Textbook of Forensic Medicine and Toxicology* (2nd edn., PEEPEE Publishers, New Delhi, 2018)

a court for the purpose of proving or disproving a fact in issue. In criminal proceedings, the prosecution and defence have the responsibility to present relevant evidence in accordance with legal procedures to establish their respective claims. Adducing forensic evidence specifically refers to the presentation of scientifically examined materials and expert opinions before the court.

Forensic evidence is generally introduced through the testimony of forensic experts who explain the methods adopted, examination conducted, and conclusions reached from the analysis of scientific materials. The expert report, along with the oral testimony of the expert, enables the court to understand the scientific significance of the evidence and assess its reliability.

The process of adducing forensic evidence requires compliance with legal and scientific standards. The evidence must be relevant, properly collected, preserved without contamination, and supported by appropriate documentation. The court must also ensure that the rights of the accused are protected while appreciating scientific evidence.

3.2 Collection of Forensic Evidence

The collection of forensic evidence is the first and one of the most crucial stages in the process of scientific investigation. The accuracy and reliability of forensic findings largely depend upon the manner in which evidence is identified, collected, and handled at the crime scene.³⁶ Even scientifically advanced methods may fail to produce reliable results if the evidence is improperly collected or contaminated during the initial stage.

The responsibility of collecting forensic evidence primarily lies with the investigating officers, who must identify relevant materials from the crime scene and ensure their safe preservation. Evidence such as blood samples, fingerprints, biological materials, firearms, digital devices, documents, and other trace materials must be collected using appropriate scientific procedures.³⁷ The use of protective equipment, proper packaging, and accurate documentation is essential to prevent contamination and maintain the integrity of evidence.

³⁶ Barry A.J. Fisher, *Techniques of Crime Scene Investigation* (8th edn., CRC Press, Boca Raton, 2012)

³⁷ B.R. Sharma, *Forensic Science in Criminal Investigation and Trials* (5th edn., Universal Law Publishing, New Delhi, 2015)

3.3 Preservation and Documentation of Evidence

Preservation and documentation of forensic evidence are essential steps in ensuring that scientific evidence retains its authenticity, reliability, and evidentiary value throughout the criminal justice process. After the collection of evidence from the crime scene, it must be carefully preserved and documented to prevent contamination, destruction, alteration, or accidental loss. Any failure during this stage may adversely affect the reliability of forensic analysis and weaken the prosecution or defence case.

Preservation involves the proper handling, packaging, storage, and transportation of evidence according to scientific procedures. Different types of forensic evidence require different preservation methods.³⁸ For example, biological samples such as blood and tissues require appropriate storage conditions to prevent deterioration, while digital evidence requires specialised procedures to prevent alteration or loss of data. Maintaining the original condition of evidence is necessary to ensure that the forensic examination produces accurate results.

3.4 Chain of Custody

The chain of custody refers to the continuous and documented process of maintaining the possession, handling, transfer, storage, and examination of forensic evidence from the time of its collection until its production before the court. It ensures that the evidence presented during trial is the same material that was collected from the crime scene and that it has not been altered, substituted, contaminated, or tampered with during the course of investigation.³⁹

The importance of maintaining the chain of custody lies in preserving the integrity and authenticity of forensic evidence. Every person who handles the evidence, including investigating officers, forensic laboratory personnel, and other authorised individuals, must be properly recorded. Details regarding the time of collection, method of packaging, transfer of custody, storage conditions, and examination process form an essential part of the chain of custody documentation.⁴⁰

³⁸ Max M. Houck & Jay A. Siegel, *Fundamentals of Forensic Science* (4th edn., Academic Press, 2019)

³⁹ Jay A. Siegel, *Forensic Science: The Basics* (3rd edn., CRC Press, Boca Raton, 2015)

⁴⁰ Scientific Working Group on DNA Analysis Methods (SWGDM), *SWGDM Best Practices Recommendations for the Collection and Preservation of Biological Evidence* (latest available version).

3.5 Examination by Forensic Experts

The examination of forensic evidence by qualified experts is a crucial stage in the process of adducing scientific evidence before courts. Forensic experts possess specialised knowledge and technical skills required to analyse materials collected during investigation and provide scientific opinions regarding their significance. Their role is to assist the court by explaining scientific findings and helping it understand matters beyond ordinary human knowledge.⁴¹

Forensic examination involves the application of scientific methods to analyse different types of evidence, including DNA samples, fingerprints, firearms, toxic substances, biological materials, digital records, and questioned documents. Experts conduct laboratory tests, interpret scientific results, and prepare detailed reports based on their observations and analysis. The accuracy of these findings depends upon the expertise of the examiner, reliability of the scientific technique used, and adherence to established laboratory standards.

3.6 Presentation of Forensic Evidence Before Courts

The presentation of forensic evidence before courts is the final stage in the process of adducing scientific evidence. After collection, preservation, and examination, the findings of forensic experts must be formally introduced during judicial proceedings so that the court can evaluate their relevance and evidentiary value. The mere existence of scientific evidence does not automatically establish a fact; it must be properly presented and explained before the court.

Forensic evidence is generally presented through two main forms: forensic reports and expert testimony. The forensic report contains details regarding the material examined, scientific methods adopted, observations made, and conclusions reached by the expert. However, in complex matters, the presence of the expert before the court becomes significant, as judges may require clarification regarding the methodology, reliability, and interpretation of scientific findings.⁴²

During trial proceedings, forensic experts may be subjected to examination-in-chief and cross-examination. Through examination-in-chief, the expert explains the scientific basis of the

⁴¹ James, Stuart H. & Jon J. Nordby, *Forensic Science: An Introduction to Scientific and Investigative Techniques* (5th edn., CRC Press, Boca Raton, 2019)

⁴² K.N. Chandrasekharan Pillai, R.V. Kelka's *Criminal Procedure* (7th edn., Eastern Book Company, Lucknow, 2024), chapter on trial and evidence.

findings, while cross-examination allows the opposing party to question the reliability, accuracy, and limitations of the expert opinion. This process ensures fairness and enables the court to critically evaluate scientific evidence rather than accepting it blindly.

4. INSTITUTIONAL FRAMEWORK FOR FORENSIC INVESTIGATION IN INDIA

The effective use of forensic evidence depends upon the functioning of various institutions involved in the criminal justice system. Forensic investigation is not carried out by a single agency but involves coordinated efforts between investigating officers, forensic laboratories, medical professionals, prosecutors, and courts.⁴³ Each institution performs a specific role in ensuring that scientific evidence is properly collected, analysed, presented, and appreciated during judicial proceedings.

The institutional framework governing forensic investigation in India consists of various governmental and professional bodies that contribute to the process of scientific investigation. These institutions are responsible for maintaining scientific standards, providing expert assistance, conducting forensic examinations, and ensuring that evidence produced before courts is reliable and legally admissible.⁴⁴

With the increasing complexity of crimes, including cybercrime, organised crime, terrorism, and financial offences, the importance of specialised forensic institutions has significantly increased. However, the effectiveness of forensic investigation depends upon adequate infrastructure, trained personnel, technological advancement, and proper coordination among different stakeholders.

The following sections examine the role and functions of various institutions involved in forensic investigation in India.

4.1 Role of the Police

The police occupy a central position in the process of forensic investigation as they are generally the first authority to respond to the commission of a crime. The initial actions taken by investigating officers at the crime scene significantly influence the quality and reliability of

⁴³ Dr. Kusum Chauhan, Role of Forensic Science in Effective Administration of Criminal Justice System in India, International Journal of Enhanced Research in Educational Development (IJERED), Vol. 10, Issue 1, Jan.–Feb. 2022

⁴⁴ Directorate of Forensic Science Services, Ministry of Home Affairs, Perspective Plan for Indian Forensics

forensic evidence collected during the investigation.

The primary responsibility of the police is to secure and preserve the crime scene, identify relevant evidence, collect materials using appropriate procedures, and ensure their safe transmission to forensic laboratories for examination. Police officers are also responsible for maintaining proper documentation and ensuring the chain of custody so that the authenticity of evidence is preserved throughout the investigation.

The increasing importance of scientific investigation has resulted in a shift from traditional investigation methods towards evidence-based investigation. The Bharatiya Nagarik Suraksha Sanhita, 2023, particularly the provisions relating to forensic investigation, emphasises the greater involvement of scientific experts in serious offences. This reflects the changing role of police from merely collecting statements to adopting scientific methods of investigation.⁴⁵

However, the effectiveness of police involvement in forensic investigation is affected by several practical limitations, including lack of specialised training, inadequate knowledge of forensic procedures, shortage of crime scene investigation units, and insufficient coordination with forensic experts.⁴⁶ These issues may result in improper collection or preservation of evidence.

4.2 Role of Forensic Science Laboratories (FSLs)

Forensic Science Laboratories (FSLs) are specialised scientific institutions that provide technical assistance to investigating agencies and courts by examining and analysing different forms of forensic evidence. They form an essential part of the criminal justice system by applying scientific methods to evidence collected during investigations and providing expert opinions regarding their findings.

The primary function of FSLs is to scientifically examine materials such as biological samples, DNA, fingerprints, firearms, toxic substances, questioned documents, and digital evidence. After conducting laboratory analysis, forensic experts prepare detailed reports explaining the methods used, observations made, and conclusions reached. These reports assist investigating

⁴⁵ Bharatiya Nagarik Suraksha Sanhita, 2023, s. 176.

⁴⁶ Bureau of Police Research and Development, Model Police Manual (Ministry of Home Affairs, Government of India, 2009), Vol. III, Chapter on Scientific Aids to Investigation.

officers, prosecutors, and courts in understanding the scientific aspects of a case.

In India, forensic laboratory services are provided through institutions such as Central Forensic Science Laboratories (CFSLS), State Forensic Science Laboratories (SFSLS), and regional forensic units. These laboratories consist of different divisions specialising in areas such as forensic biology, chemistry, toxicology, ballistics, cyber forensics, and document examination. Their multidisciplinary nature enables comprehensive scientific investigation of complex offences.⁴⁷

The importance of FSLs has increased significantly due to the growing complexity of crimes. Offences involving cyber technology, organised criminal activities, financial fraud, and sophisticated methods of crime require advanced scientific analysis. The availability of modern forensic facilities enables investigators to move beyond traditional methods and adopt evidence-based approaches.

4.3 Role of Medical Experts and Forensic Experts

Medical experts and forensic experts play a significant role in the criminal justice system by providing scientific opinions that assist courts in understanding facts relating to injuries, causes of death, biological evidence, and other medical or technical issues. Their expertise helps in establishing the connection between the accused, victim, and circumstances surrounding the commission of an offence.

Medical experts are primarily involved in medico-legal examination, including examination of injured persons, victims of sexual offences, accused persons, and deceased individuals. They prepare medical reports, conduct post-mortem examinations, analyse injuries, determine the cause and manner of death, and provide opinions regarding the nature and timing of injuries.⁴⁸ Their findings may provide crucial evidence in offences such as murder, sexual assault, physical violence, and poisoning cases.

Forensic experts, on the other hand, examine scientific evidence collected during investigation through specialised disciplines such as forensic biology, DNA analysis, toxicology, ballistics,

⁴⁷ Directorate of Forensic Science Services, Ministry of Home Affairs, Government of India, Directorate of Forensic Science Services (DFSS).

⁴⁸ Apurba Nandy, Principles of Forensic Medicine including Toxicology, 4th edn. (New Central Book Agency, 2020).

fingerprints, digital forensics, and document examination. They analyse the evidence using scientific methods and provide expert reports that assist courts in evaluating facts beyond ordinary human knowledge.⁴⁹

4.4 Role of the Prosecution

The prosecution plays a crucial role in ensuring that forensic evidence collected during investigation is properly presented and effectively utilised during criminal trials. The prosecutor acts as a link between the investigating agency, forensic experts, and the court by analysing the evidence available on record and presenting it in a legally acceptable manner.

The primary responsibility of the prosecution is to examine the forensic reports, understand their scientific significance, and place them before the court along with other evidence. Prosecutors must ensure that forensic evidence is supported by proper documentation, maintained through an unbroken chain of custody, and presented through competent expert testimony whenever required.⁵⁰ They must also assist the court in understanding complex scientific findings without misrepresenting or overstating their value.

The role of the prosecutor is not limited to securing convictions but also includes ensuring a fair trial. Therefore, the prosecution must present scientific evidence objectively and disclose relevant materials that may affect the determination of guilt or innocence.⁵¹ Proper appreciation of forensic evidence by prosecutors helps prevent wrongful convictions and strengthens the credibility of criminal proceedings.

With the increasing importance of scientific evidence, prosecutors require specialised knowledge regarding forensic techniques, limitations of scientific methods, and interpretation of expert opinions. Lack of adequate training may result in improper presentation of forensic evidence or failure to effectively utilise valuable scientific findings during trial.

The Supreme Court, in *Shiv Kumar v. Hukam Chand*,⁵² highlighted the important role of prosecutors in assisting courts and ensuring the proper conduct of criminal trials. The Court

⁴⁹ B. R. Sharma, *Forensic Science in Criminal Investigation and Trials*, 6th edn. (Universal Law Publishing, 2019).

⁵⁰ Sunaina Jeevnani, "Role of Forensic Evidence in Indian Criminal Justice System," *Indian Journal of Legal Review*, Vol. 4, Issue 4 (2024)

⁵¹ Law Commission of India, 154th Report on the Code of Criminal Procedure, 1973 (1996), Ch. XXV (Prosecution Agency).

⁵² 1999 (7) SCC 467.

observed that prosecutors represent the interests of justice and must act fairly rather than merely seek conviction.

4.5 Role of the Judiciary

The judiciary plays a vital role in evaluating and appreciating forensic evidence presented during criminal proceedings. While forensic science provides scientific assistance in determining facts, it is ultimately the responsibility of courts to assess the reliability, relevance, and evidentiary value of such evidence. Judges must carefully examine scientific findings along with other evidence available on record before arriving at conclusions regarding the guilt or innocence of an accused.

The role of the judiciary is not merely to accept forensic evidence mechanically but to critically analyse the methodology adopted, the competence of experts, the circumstances in which evidence was collected, and whether proper procedures were followed. Courts must ensure that scientific evidence satisfies the requirements of fairness, reliability, and legality before placing reliance upon it.⁵³

Judicial interpretation has significantly contributed to the development of principles governing the use of forensic evidence in India. Courts have recognised the importance of scientific investigation while also cautioning against excessive dependence on forensic evidence without proper evaluation. Expert opinions are treated as relevant evidence, but they remain subject to judicial scrutiny.

The Supreme Court, in *Magan Bihari Lal v. State of Punjab*,⁵⁴ observed that handwriting expert evidence is a weak type of evidence and should generally be considered along with other corroborative evidence. The judgment highlights that expert opinion requires careful judicial assessment and cannot be accepted without proper examination.

4.6 National and State Forensic Institutions

Forensic investigation in India is supported by various national and state-level institutions that provide scientific assistance to investigating agencies and courts. These institutions are

⁵³ Vidit Rastogi & Prashant Kumar Varun, "The Role of Forensic Science in Criminal Justice System of India: A Critical Analysis," *Indian Journal of Legal Review*, Vol. 5, Issue 5 (2025).

⁵⁴ (1977) 2 SCC 210

responsible for conducting forensic examinations, developing scientific expertise, maintaining research facilities, and improving the quality of evidence-based investigation. Their effective functioning is essential for ensuring that forensic science contributes meaningfully to the criminal justice system.

At the national level, the Central Forensic Science Laboratories (CFSLS) function as important institutions providing specialised forensic services. These laboratories operate under the Directorate of Forensic Science Services (DFSS) and undertake examination of complex forensic evidence relating to areas such as DNA analysis, cyber forensics, ballistics, toxicology, and document examination. They also contribute to research, training, and development of forensic techniques.⁵⁵

At the state level, State Forensic Science Laboratories (SFSLS) and regional forensic units provide scientific assistance to state police departments and courts. They examine evidence collected during criminal investigations and prepare expert reports that assist in prosecution and judicial decision-making. These institutions generally contain specialised divisions dealing with forensic biology, chemistry, physics, questioned documents, cyber forensics, and other branches of forensic science.⁵⁶

Another significant institution is the National Forensic Sciences University (NFSU), established to promote education, research, and training in forensic science and related fields. It aims to develop skilled forensic professionals and strengthen the scientific capacity of the criminal justice system. Similarly, the National Forensic Science Laboratory (NFSL) and other specialised institutions contribute towards improving forensic capabilities in India.

Despite the existence of various forensic institutions, several challenges continue to affect their effectiveness. These include inadequate infrastructure, shortage of trained experts, outdated technology, insufficient funding, and delays in examination of forensic samples. The increasing volume and complexity of criminal cases have created additional pressure on existing forensic facilities.

⁵⁵ Kanak Singh, "Strengthening Forensic Infrastructure in India: An Analytical Study of Institutional Deficits and Legal Challenges," *Journal of Advances and Scholarly Researches in Allied Education* (2023).

⁵⁶ Law Commission of India, 185th Report on Review of the Indian Evidence Act, 1872 (2003), Ch. VII (Expert Opinion).

5. INSTITUTIONAL LOOPHOLES IN ADDUCING FORENSIC EVIDENCE

Forensic science has become an essential component of modern criminal investigation, providing scientific methods for identifying offenders, establishing facts, and assisting courts in the administration of justice. However, the effectiveness of forensic evidence depends largely upon the proper functioning of the institutions involved in its collection, examination, preservation, and presentation. Despite significant developments in forensic technology, various institutional deficiencies continue to affect the effective utilisation of forensic evidence in India.

The process of adducing forensic evidence involves multiple agencies, including the police, forensic laboratories, medical experts, prosecutors, and courts. Any weakness or lack of coordination among these institutions may reduce the reliability and evidentiary value of scientific findings. Problems such as delay in investigation, inadequate infrastructure, shortage of trained experts, improper handling of evidence, and lack of technological advancement create obstacles in the effective use of forensic science.

These institutional loopholes not only delay criminal trials but may also result in wrongful convictions or acquittals due to unreliable or insufficient evidence. The issue becomes more significant in serious offences such as murder, sexual offences, terrorism, and organised crime, where scientific evidence can play a decisive role.⁵⁷

Therefore, while forensic science has immense potential to strengthen the criminal justice system, institutional limitations often prevent its full effectiveness. The following sections examine the major loopholes affecting the process of adducing forensic evidence in India.

5.1 Delay in Collection of Evidence

The timely collection of forensic evidence is one of the most important requirements for ensuring accurate scientific analysis. Evidence available at the crime scene may deteriorate, become contaminated, or lose its relevance if it is not collected promptly. Delay in collecting biological samples, fingerprints, digital evidence, and other materials can significantly affect

⁵⁷ Sandhya Verma & Anjum Parvez, "Institutional Problems in the Indian Judicial System Relating to Admissibility of Scientific Evidence: Causes and Remedies," *IP International Journal of Forensic Medicine and Toxicological Sciences*, Vol. 6, No. 2 (2021)

the quality and reliability of forensic examination.

The responsibility of immediate evidence collection primarily lies with investigating officers. However, practical difficulties such as inadequate training, lack of specialised crime scene units, shortage of personnel, and insufficient awareness regarding forensic procedures often result in delays. In many cases, police investigations continue using traditional methods without immediate involvement of forensic experts, causing valuable scientific evidence to be lost.⁵⁸

Delay in collection is particularly problematic in cases involving biological evidence such as blood, semen, and other body fluids. Such evidence requires timely preservation under appropriate conditions to prevent degradation. Similarly, digital evidence may be altered, deleted, or overwritten if not secured immediately.⁵⁹

5.2 Delay in Forensic Examination and Laboratory Reports

Delay in forensic examination and submission of laboratory reports is one of the major institutional challenges affecting the effective use of forensic evidence in India. After the collection of evidence from the crime scene, the materials must be scientifically analysed by forensic laboratories. However, due to increasing workload, shortage of experts, limited laboratory facilities, and procedural delays, forensic reports often take considerable time to be prepared and submitted before courts.⁶⁰

The delay in obtaining forensic reports directly affects the progress of criminal investigations and trials. In serious offences such as murder, sexual offences, and cases involving DNA evidence, forensic reports may become crucial in determining the guilt or innocence of the accused. Unnecessary delay may result in prolonged detention of accused persons, delay in justice for victims, and weakening of evidence due to deterioration or loss of relevance.

One of the major reasons for delays is the imbalance between the number of forensic samples received and the available capacity of forensic laboratories. Many laboratories face shortage of

⁵⁸ Vivek Sahajpal & Deepika Bhandari, "DNA Profiling in India: Addressing Issues of Sample Preservation, Databasing, Marker Selection, & Statistical Approaches," *Science & Justice*, Vol. 64, Issue 4 (2024)

⁵⁹ M.M. Evans, P.A. Stagner & R. Rooms, "Maintaining the Chain of Custody: Evidence Handling in Forensic Cases," *AORN Journal*, Vol. 78, No. 4 (2003)

⁶⁰ J. M. Butler, *Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers*, 2nd ed. (Elsevier Academic Press, 2005).

qualified forensic scientists, inadequate equipment, and insufficient specialised divisions. The increasing dependence on scientific investigation without corresponding institutional expansion has resulted in significant backlogs.⁶¹

5.3 Inadequate Infrastructure and Technology

Adequate infrastructure and advanced technology are essential for the effective functioning of forensic institutions. Modern crimes often involve complex scientific evidence requiring sophisticated equipment, specialised laboratories, and updated forensic techniques. However, many forensic institutions in India continue to face limitations in infrastructure and technological resources.⁶²

Several forensic laboratories operate with outdated equipment and insufficient facilities, affecting their ability to conduct advanced examinations efficiently. Areas such as DNA profiling, cyber forensics, digital evidence analysis, and advanced toxicology require continuous technological development. Lack of modern facilities may reduce the accuracy and speed of forensic analysis.

The absence of adequate infrastructure also affects the quality of evidence produced before courts. Scientific methods require controlled laboratory environments, proper storage facilities, and quality assurance mechanisms. Without these requirements, questions may arise regarding the reliability of forensic findings.⁶³

The growth of cybercrime has further increased the demand for advanced digital forensic facilities. However, limited availability of specialised cyber forensic units and trained personnel creates difficulties in investigating technology-based offences.

5.4 Shortage of Skilled Forensic Experts

The availability of qualified and experienced forensic experts is essential for accurate examination and interpretation of scientific evidence. Forensic science involves specialised fields such as DNA analysis, forensic medicine, toxicology, ballistics, cyber forensics, and

⁶¹ B. B. Nanda & R. K. Tewari, *Forensic Science in India: A Vision for the Twenty First Century* (Select Publishers, New Delhi, 2001).

⁶² Peter White, *Crime Scene to Court: The Essentials of Forensic Science* (Royal Society of Chemistry, 2010).

⁶³ Max M. Houck (ed.), *Forensic Chemistry* (Academic Press, 2015).

document examination, each requiring specialised knowledge and training.

However, India faces a shortage of skilled forensic professionals due to limited training facilities, insufficient recruitment, heavy workload, and lack of attractive professional opportunities. The shortage of experts places additional pressure on existing forensic personnel and contributes to delays in examination and reporting.⁶⁴

The absence of adequate manpower may also affect the quality of forensic analysis. Scientific evidence requires careful interpretation, and insufficient expertise may lead to errors or inconsistent conclusions. Continuous professional training and exposure to advanced forensic techniques are necessary to maintain scientific standards.⁶⁵

5.5 Improper Collection and Preservation of Evidence

The accuracy and reliability of forensic evidence largely depend upon the manner in which evidence is collected and preserved during investigation. Improper collection, handling, packaging, or storage of evidence may result in contamination, destruction, or alteration of scientific materials, thereby reducing their evidentiary value before courts.⁶⁶

The responsibility of collecting forensic evidence primarily rests with investigating officers, who must follow scientific procedures while dealing with materials obtained from crime scenes. However, lack of adequate training, insufficient knowledge of forensic protocols, and absence of specialised crime scene management units often lead to mistakes during evidence collection.⁶⁷ Such errors may permanently affect the possibility of obtaining accurate forensic results.

Preservation of evidence is equally important because different forms of forensic materials require different methods of storage and handling. Biological evidence such as blood, semen, and tissues may deteriorate if not preserved properly, while digital evidence may be altered if appropriate forensic procedures are not followed. Therefore, maintaining the original condition

⁶⁴ Douglas H. Ubelaker, "The Global Practice of Forensic Science," *Forensic Science International*, Vol. 232 (2013)

⁶⁵ Joe H. Smith & J. S. Horne, "Why Down-managing Backlog Forensic DNA Case Entries Matters," *Journal of Forensic Science and Research*, Vol. 8, No. 1 (2024)

⁶⁶ Suzanne Bell, *Forensic Chemistry* (2nd ed., Pearson Education, 2013).

⁶⁷ National Institute of Justice (U.S. Department of Justice), *Crime Scene Investigation: A Guide for Law Enforcement* (2nd ed., 2013).

of evidence is essential for ensuring its authenticity.

Improper documentation is another major issue affecting forensic evidence. Details regarding the location of evidence, time of collection, person responsible for handling it, and method of preservation must be accurately recorded. Failure to maintain proper records may create doubts regarding the reliability of evidence during trial.

The Supreme Court, in *Pattu Rajan v. State of Tamil Nadu*,⁶⁸ emphasised that scientific evidence must be appreciated carefully and its reliability depends upon proper procedures adopted during investigation.

5.6 Break in the Chain of Custody

The chain of custody is an essential safeguard that ensures the integrity and authenticity of forensic evidence from the time of collection until its presentation before the court. A break in this chain occurs when there is an unexplained gap or irregularity in the handling, transfer, storage, or examination of evidence.

Maintaining an unbroken chain of custody is particularly important in cases involving biological evidence, narcotic substances, firearms, and digital records. Since such evidence can be easily contaminated, altered, or substituted, every transfer of evidence must be properly documented.⁶⁹ Any failure to establish continuity may create reasonable doubt regarding the genuineness of the evidence.

In India, breaks in the chain of custody often occur due to poor documentation, improper storage facilities, lack of trained personnel, and inadequate coordination between police officers and forensic laboratories. Such institutional failures may result in courts giving reduced importance to forensic evidence or rejecting it altogether.

The Supreme Court, in *State of Rajasthan v. Daulat Ram*,⁷⁰ highlighted the importance of proving that seized materials remained intact and were properly handled before being produced before the court. The judgment demonstrates the significance of maintaining the integrity of

⁶⁸ (2019) 4 SCC 771

⁶⁹ Jay A. Siegel & Kathy Mirakovits, *Forensic Science: The Basics* (3rd ed., CRC Press, 2016).

⁷⁰ (AIR 1980 SC 1314)

physical evidence.

5.7 Lack of Coordination Among Police, FSLs and Prosecutors

Effective use of forensic evidence requires close coordination between different institutions involved in the criminal justice process, particularly the police, forensic laboratories, and prosecution agencies. Each institution performs a distinct function, and lack of cooperation among them may significantly affect the quality and effectiveness of forensic investigation.⁷¹

The police are responsible for identifying and collecting evidence, forensic laboratories analyse the collected materials, and prosecutors present the findings before courts. A proper flow of communication between these institutions is necessary to ensure that evidence is collected according to scientific requirements and presented effectively during trial.

However, in practice, inadequate coordination often creates difficulties. Investigating officers may fail to provide complete information to forensic experts, laboratories may face delays due to improper submission of samples, and prosecutors may lack sufficient understanding of complex scientific findings. Such gaps can weaken the presentation of forensic evidence before courts.

The absence of regular interaction and training programmes among these stakeholders further contributes to institutional inefficiency. Effective forensic investigation requires a multidisciplinary approach where police officers, scientists, and legal professionals understand each other's roles and requirements.⁷²

The Supreme Court, in *Manoj v. State of Madhya Pradesh*,⁷³ emphasised the importance of proper investigation and effective use of scientific evidence, highlighting the need for better investigative practices.

5.8 Risk of Contamination and Human Error

Contamination and human error are significant factors that may affect the reliability and

⁷¹ Anika Ludwig & Jim Fraser, "Effective Use of Forensic Science in Volume Crime Investigations: Identifying Recurring Themes in the Literature," *Science & Justice*, Vol. 54, No. 1 (2014)

⁷² National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (National Academies Press, 2009).

⁷³ (2023) 2 SCC 353

accuracy of forensic evidence. Since forensic examination depends upon the scientific analysis of materials collected from crime scenes, even minor mistakes during collection, handling, transportation, or examination may alter the results and reduce the evidentiary value of such evidence.⁷⁴

Contamination occurs when foreign materials are unintentionally introduced into forensic samples, affecting their original condition. This is particularly important in cases involving DNA and biological evidence, where improper handling may lead to inaccurate results. Failure to use protective equipment, inadequate separation of samples, improper storage, and lack of scientific protocols are common causes of contamination.

Apart from contamination, human error may occur at different stages of the forensic process. Errors in identifying evidence, recording information, analysing samples, interpreting results, or preparing reports may affect the reliability of forensic findings. Since forensic evidence is often considered highly persuasive, mistakes in scientific analysis may have serious consequences, including wrongful conviction or failure to identify the actual offender.⁷⁵

The risk of human error highlights the importance of quality control mechanisms, regular training of forensic personnel, standard operating procedures, and independent review of scientific findings. Forensic science requires continuous monitoring to ensure that conclusions are based on accurate methods rather than individual assumptions.

Therefore, contamination and human error represent serious challenges affecting the credibility of forensic evidence. Strengthening laboratory standards, improving professional training, and implementing strict quality assurance measures are essential to minimise such risks.

6. CONCLUSION

Forensic science has emerged as an essential component of the modern criminal justice system by providing scientific methods for investigation, identification, and analysis of evidence. The advancement of forensic techniques has significantly improved the ability of investigating agencies and courts to discover the truth and ensure effective administration of justice.

⁷⁴ Jan Gruber, Christopher J. Hargreaves & Felix C. Freiling, "Contamination of Digital Evidence: Understanding an Underexposed Risk," *Forensic Science International: Digital Investigation*, Vol. 44 (2023)

⁷⁵ Paul C. Giannelli, "Wrongful Convictions and Forensic Science: The Need to Regulate Crime Labs," *North Carolina Law Review*, Vol. 86 (2007)

Scientific evidence such as DNA profiling, toxicological examination, digital forensics, and other specialised methods has contributed greatly to criminal investigations.

However, the effectiveness of forensic evidence depends not only on scientific advancement but also on the strength of institutional mechanisms supporting its collection, examination, and presentation before courts. The study reveals that several institutional loopholes affect the reliability of forensic evidence in India. Problems such as delay in forensic examination, inadequate infrastructure, shortage of trained experts, improper collection and preservation of evidence, break in the chain of custody, and lack of coordination among investigating agencies reduce the effectiveness of forensic investigation.

The debate regarding the description of forensic science as “junk science” highlights the importance of scientific reliability and validation. While criticism against certain forensic techniques is justified due to concerns relating to lack of empirical research, subjectivity, and absence of standardised procedures, it would be incorrect to consider the entire field of forensic science as unreliable. Many forensic techniques, particularly DNA profiling, forensic toxicology, and advanced digital forensic methods, are based on strong scientific foundations and have made significant contributions to justice delivery.

The judiciary has adopted a balanced approach by recognising the importance of forensic evidence while emphasising the need for careful evaluation of its reliability. Courts have repeatedly observed that expert opinions are valuable assistance but cannot replace judicial scrutiny. Scientific evidence must satisfy legal and scientific standards before being relied upon for determining guilt or innocence.

The increasing use of forensic science under the Bharatiya Nagarik Suraksha Sanhita, 2023 reflects a shift towards scientific investigation in India. However, legislative recognition alone is insufficient unless supported by adequate infrastructure, trained professionals, quality control mechanisms, and effective institutional coordination.

Therefore, the future of forensic science in India depends upon strengthening forensic institutions, improving scientific standards, investing in research and training, and ensuring accountability in the use of scientific evidence. Rather than rejecting forensic science as “junk science,” the focus should be on identifying unreliable methods and developing a scientifically rigorous forensic system.

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