

Forensic Science and Criminal Investigation: It's Role in the Administration of Justice

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Abstract:

Forensic science plays a crucial role in modern criminal investigations and significantly contributes to the effective administration of justice. It refers to the application of scientific principles, techniques, and methodologies in the examination and analysis of physical evidence associated with criminal activities. Techniques such as DNA profiling, fingerprint analysis, toxicology, ballistics, and digital forensics enable investigators to identify offenders, establish factual links, and reconstruct crime scenes with a high degree of precision and reliability. The incorporation of forensic science into the criminal justice system has greatly improved the accuracy, credibility, and objectivity of criminal investigations. Scientific evidence assists law enforcement agencies and judicial authorities in determining the guilt or innocence of the accused, thereby reducing the risk of wrongful convictions and miscarriages of justice. Moreover, forensic findings enhance the evidentiary value of material presented before courts, ensuring that judicial decisions are grounded in scientifically validated and reliable information. Furthermore, the use of forensic science strengthens transparency and fairness in the investigative process by reducing excessive reliance on confessions and eyewitness testimonies, which may sometimes be unreliable. Rapid technological advancements have expanded the scope and efficiency of forensic techniques, enabling investigators to address increasingly complex and sophisticated crimes. Despite these developments, several challenges—such as inadequate infrastructure, shortage of trained forensic experts, and delays in the submission of forensic reports—continue to affect the timely delivery of justice in many jurisdictions.

Keywords: Administration of Justice, Scientific Evidence, DNA Profiling, Fingerprint Analysis, Ballistics, Toxicology, Digital Forensics

Introduction:

Forensic science has become an essential component of modern criminal investigations and plays a significant role in the effective administration of justice. It refers to the application of scientific principles and techniques to matters related to law, particularly in the detection, investigation, and adjudication of crimes. By analyzing physical evidence collected from crime scenes, forensic science helps investigators establish facts, identify suspects, and reconstruct events surrounding a criminal

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act. Traditionally, criminal investigations relied heavily on confessions, eyewitness testimonies, and circumstantial evidence. However, such forms of evidence are sometimes unreliable and may lead to errors in the judicial process. With the advancement of scientific methods, forensic science has introduced greater accuracy, objectivity, and reliability into criminal investigations. Techniques such as DNA profiling, fingerprint analysis, ballistics examination, toxicological testing, and digital forensics provide scientific support in linking suspects with crimes and verifying the authenticity of evidence.

The growing importance of forensic science has significantly strengthened the criminal justice system. Scientific evidence presented before courts assists judges in making informed and fair decisions by providing objective proof regarding the commission of a crime and the involvement of the accused. Consequently, forensic science not only aids in the conviction of guilty persons but also protects innocent individuals from wrongful punishment. In recent decades, rapid technological advancements have expanded the scope of forensic science, enabling investigators to address complex and sophisticated forms of crime, including cybercrime, organized crime, and financial fraud. Despite these developments, challenges such as limited forensic infrastructure, shortage of skilled experts, and delays in forensic examination continue to hinder the effective utilization of forensic science in many countries. Therefore, the integration of forensic science with criminal investigation is indispensable for ensuring transparency, efficiency, and fairness in the administration of justice. By providing scientifically reliable evidence, forensic science strengthens the rule of law and contributes to the delivery of justice in a systematic and credible manner.

Historical Back Ground:

The development of forensic science has a long historical background that reflects the gradual integration of scientific knowledge into the criminal justice system. The earliest references to forensic practices can be traced back to ancient civilizations where rudimentary methods were used to investigate crimes and determine the cause of death. Ancient societies such as those in China, Egypt, and India applied basic observational techniques to identify injuries, poisoning, and other causes of death. During the medieval period, criminal investigations relied mainly on confessions, eyewitness accounts, and ordeals rather than scientific analysis. However, the foundations of modern forensic science began to emerge in the 16th and 17th centuries with the advancement of medical science. Physicians started to assist courts by providing expert opinions regarding injuries, causes of death, and other medico-legal issues. This period marked the beginning of the application of medical knowledge in legal proceedings, which later developed into the field of forensic medicine.

The 19th century witnessed significant progress in forensic science due to rapid developments in chemistry, biology, and medicine. In 1835, the scientist James Marsh developed the Marsh Test for detecting arsenic poisoning, which became an important tool in criminal investigations involving toxic substances. Later, in the late 19th century, Alphonse Bertillon introduced the system of anthropometry for the identification of criminals based on body measurements. Although this system

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was later replaced, it laid the groundwork for scientific methods of criminal identification. A major breakthrough occurred with the discovery and development of fingerprint identification. In the late 19th century, Sir Francis Galton scientifically established the uniqueness and permanence of fingerprints, which led to their widespread use in criminal investigations. Fingerprint analysis soon became one of the most reliable methods of identifying offenders and linking them to crime scenes.

The 20th century marked the expansion of forensic science as a multidisciplinary field. Scientific techniques such as blood grouping, ballistic analysis, document examination, and toxicology became widely used in criminal investigations. Later developments, including DNA profiling in the 1980s, revolutionized forensic science by enabling highly accurate identification of individuals through biological evidence. DNA analysis has since become one of the most powerful tools in solving crimes, identifying victims, and exonerating wrongfully accused individuals. In contemporary times, forensic science has expanded further with the emergence of advanced technologies such as digital forensics, cyber forensics, and forensic anthropology. These developments have strengthened the capacity of criminal justice systems to investigate complex crimes and present reliable scientific evidence before courts. Thus, the historical development of forensic science demonstrates a gradual transition from traditional investigative methods to scientifically based approaches. Over time, forensic science has become an indispensable tool in criminal investigation, significantly contributing to the effective and fair administration of justice.

Legislative Aspects:

The effective use of forensic science in criminal investigation is supported and regulated by various legislative provisions that govern the collection, preservation, examination, and admissibility of scientific evidence. In India, the legal framework for the application of forensic science is primarily derived from criminal procedural laws, evidentiary rules, and specific statutes that recognize the value of scientific and expert evidence in the administration of justice.

One of the most important legislative provisions is contained in the Indian Evidence Act, 1872, which provides the legal basis for the admissibility of expert evidence. Section 45 of the Act recognizes the opinions of experts in fields such as science, handwriting, fingerprints, and other specialized areas as relevant facts in judicial proceedings. This provision allows courts to rely on the testimony of forensic experts when determining matters requiring scientific knowledge. Similarly, Sections 46 and 51 further support the consideration of expert opinions and the grounds upon which such opinions are based.

Another significant statute is the Code of Criminal Procedure, 1973, which contains several provisions relating to the use of forensic techniques during criminal investigations. Section 53 and Section 53A empower medical practitioners to examine an accused person at the request of a police officer when such examination may provide evidence related to the commission of a crime. Section 164A provides for the medical examination of victims in cases such as sexual offences. These

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provisions ensure that scientific methods are lawfully used to collect crucial forensic evidence.

The importance of forensic science has also been strengthened under the Bharatiya Nagarik Suraksha Sanhita, 2023, which replaced the earlier criminal procedure framework and emphasizes the use of modern investigative techniques. The new law promotes the use of forensic evidence in serious criminal cases and encourages the development of forensic infrastructure to improve the efficiency of investigations.

Additionally, the Bharatiya Sakshya Adhiniyam, 2023—which replaces the earlier Evidence Act—retains and further clarifies the importance of expert opinion and electronic evidence in judicial proceedings. It recognizes the growing role of scientific and digital evidence in modern criminal trials and provides a legal basis for their admissibility before courts.

Apart from these statutes, various special laws also incorporate forensic procedures. For instance, laws dealing with narcotics, cybercrime, terrorism, and sexual offences often rely heavily on forensic examination of evidence such as digital data, biological samples, and chemical substances. These legislative measures ensure that scientific techniques are properly integrated into the investigative and judicial processes. Therefore, the legislative framework plays a crucial role in institutionalizing the use of forensic science within the criminal justice system. By recognizing the admissibility of expert opinions and regulating the collection and analysis of scientific evidence, the law ensures that forensic science contributes effectively to fair trials, accurate investigations, and the overall administration of justice.

Global Approach:

Forensic science has gained global recognition as an essential component of modern criminal investigation and the administration of justice. Across the world, countries have increasingly adopted scientific methods and advanced technologies to strengthen their criminal justice systems. The integration of forensic science into investigative procedures has improved the accuracy, transparency, and reliability of criminal investigations, thereby enhancing public confidence in the justice delivery system.

Internationally, forensic science is widely used by law enforcement agencies to analyze and interpret physical evidence obtained from crime scenes. Techniques such as DNA profiling, fingerprint analysis, forensic toxicology, ballistic examination, and digital forensics are commonly applied in criminal investigations across many jurisdictions. These scientific methods help investigators identify suspects, link individuals to crime scenes, and reconstruct events related to criminal activities with greater precision.

Global organizations have also played an important role in promoting the development and standardization of forensic science. Institutions such as the International Criminal Police Organization (INTERPOL) facilitate cooperation among law enforcement agencies of different

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countries by sharing forensic data, criminal intelligence, and best investigative practices. Similarly, the United Nations Office on Drugs and Crime supports member states in strengthening their forensic capabilities and criminal justice systems through technical assistance, training programs, and policy guidance.

Many developed countries have established advanced forensic laboratories and research institutions to support criminal investigations. For example, the Federal Bureau of Investigation in the United States operates one of the world's largest and most sophisticated forensic laboratories, providing scientific support in areas such as DNA analysis, digital forensics, and trace evidence examination. Likewise, countries in Europe, Australia, and Japan have developed strong forensic infrastructures that assist law enforcement agencies in solving complex crimes and ensuring effective prosecution. In recent years, globalization and technological advancements have further expanded the scope of forensic science, particularly in addressing transnational crimes such as cybercrime, human trafficking, terrorism, and financial fraud. Digital forensics and international data-sharing mechanisms have become crucial tools for combating such crimes, as criminal activities increasingly cross national borders. Despite these advancements, many developing countries still face challenges in fully implementing forensic science due to limited infrastructure, lack of trained personnel, and financial constraints. International cooperation, capacity-building initiatives, and knowledge sharing are therefore essential to strengthen forensic systems worldwide. The global approach to forensic science reflects a growing recognition of its importance in modern criminal investigations. By promoting scientific methods, international collaboration, and technological innovation, forensic science plays a vital role in ensuring fairness, efficiency, and credibility in the administration of justice across the world.

Judicial Trends:

The judiciary has played a significant role in recognizing and strengthening the importance of forensic science in criminal investigations and the administration of justice. Courts have increasingly emphasized the value of scientific evidence in determining the truth and ensuring fair trials. Judicial decisions have consistently highlighted that forensic evidence provides greater reliability and objectivity compared to traditional forms of evidence such as confessions or eyewitness testimony.

One of the landmark judgments in this regard is *State of Bombay v. Kathi Kalu Oghad*, where the Supreme Court clarified that the collection of physical evidence such as fingerprints, handwriting samples, or other bodily materials from an accused does not violate the constitutional protection against self-incrimination. This judgment established an important legal foundation for the use of forensic techniques during criminal investigations. In *Selvi v. State of Karnataka*, the Supreme Court examined the legality of certain investigative techniques such as narco-analysis, polygraph tests, and brain-mapping. The Court held that involuntary administration of these tests violates the right against self-incrimination and personal liberty. However, it also recognized that such techniques may be used with the voluntary consent of the accused under strict legal safeguards. The judiciary has

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also acknowledged the importance of DNA evidence in criminal trials. In Santosh Kumar Singh v. State, forensic evidence, particularly DNA analysis, played a crucial role in establishing the guilt of the accused and overturning the earlier acquittal. The case highlighted the reliability of scientific evidence in strengthening the criminal justice process. In Mukesh v. State (NCT of Delhi), related to the widely known Nirbhaya case, forensic evidence such as DNA profiling, medical examination, and other scientific analyses were heavily relied upon by the courts to confirm the involvement of the accused. The case demonstrated how forensic science can provide conclusive evidence in serious criminal offences.

In recent years, courts have increasingly encouraged the use of modern forensic techniques to improve the quality of investigations. Judicial observations often stress that scientific investigation helps in uncovering the truth, preventing wrongful convictions, and ensuring that justice is delivered based on credible and objective evidence. Thus, judicial trends clearly indicate a growing reliance on forensic science in criminal investigations. Through progressive interpretations and landmark decisions, the judiciary has strengthened the role of scientific evidence in ensuring fairness, accuracy, and effectiveness in the administration of justice.

Conclusion:

Forensic science has emerged as an indispensable tool in modern criminal investigation and plays a pivotal role in strengthening the administration of justice. By applying scientific principles and advanced technological methods, forensic science enhances the accuracy, reliability, and credibility of criminal investigations. It assists law enforcement agencies in collecting, analyzing, and interpreting physical evidence, thereby helping to establish the truth and ensure that justice is delivered effectively.

The growing reliance on scientific evidence has significantly improved the functioning of the criminal justice system. Techniques such as DNA profiling, fingerprint analysis, ballistics examination, toxicology, and digital forensics have made it possible to identify offenders with greater precision and to reconstruct crime scenes more accurately. These methods not only aid in the conviction of guilty individuals but also play a crucial role in protecting innocent persons from wrongful prosecution and punishment.

Furthermore, the legislative framework and judicial interpretations have increasingly recognized the importance of forensic science in criminal investigations. Courts have acknowledged the evidentiary value of expert opinions and scientific analysis, thereby encouraging the use of modern forensic techniques in the investigative process. At the global level, international cooperation and technological advancements have further strengthened the role of forensic science in addressing complex and transnational crimes.

However, despite its significant contributions, several challenges remain, particularly in developing countries. Issues such as inadequate forensic infrastructure, shortage of trained professionals, delays

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in forensic reporting, and lack of awareness regarding scientific investigation often hinder the effective use of forensic science. Addressing these challenges requires increased investment in forensic laboratories, specialized training for investigators, and the development of efficient institutional frameworks. The integration of forensic science with criminal investigation is essential for ensuring transparency, fairness, and efficiency in the administration of justice. The effective utilization of scientific evidence not only enhances the credibility of the criminal justice system but also strengthens the rule of law by ensuring that justice is based on objective and reliable proof. Therefore, the continued development and proper implementation of forensic science are crucial for achieving a more effective and just legal system.

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