Integrating Science and Law: A Forensic Justice Perspective

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Abstract

Forensic justice offers a fresh viewpoint that combines forensic science with the legal framework, improving the scrutiny and interpretation of evidence, while strengthening the reliability and effectiveness of legal processes. It is in harmony with the core principles of equality and the Law of Evidence, requiring steadfast adherence to regulations and improving accountability within the criminal justice system. In India, forensics plays a crucial role in post-crime investigations. It involves the careful collection and analysis of evidence at the crime scene, which helps enforcement agencies construct strong cases grounded in scientific evidence. Nonetheless, using forensics in investigations comes with various challenges, with the most significant being the unclear standards regarding the acceptance of forensic evidence in court. The Allahabad High Court, in the case of Titli v. Alfred Robert John, set forth the standards for admitting expert evidence, highlighting its importance and dependability. The Supreme Court of India set out eight criteria for admissibility, yet there is still some uncertainty regarding how they are applied.

Forensic intelligence plays a crucial role in preventing and predicting crime by utilizing pattern recognition and criminal profiling techniques. In many areas, such as India, forensic justice has yet to fully achieve its potential in preventing, investigating, and prosecuting crimes. This article seeks to highlight the insufficient use of forensic science in investigations following crimes and the absence of forensic intelligence in efforts to prevent crimes before they occur. The focus is on how forensic science is integrated into criminal investigations, examining its practical use and suggesting changes to tackle the challenges encountered by law enforcement and the judiciary.

This article examines how forensic justice can transform the Indian legal system by incorporating forensics into both pre- and post-crime policies, while also addressing the institutional obstacles that impede its integration into the justice framework.

Keywords: Justice, post-crime investigation, pre-crime prevention, Forensic Intelligence.

Introduction

Forensic justice is a multifaceted blend of scientific techniques, legal principles, and ethical considerations, consistently striving to ensure fairness and efficiency in the justice system. At the heart of this intricate concept lies the ability to accurately interpret and utilize forensic evidence—an elaborate task that demands a profound understanding and specialized knowledge. The core principles of forensic justice play a crucial role in assessing whether scientific evidence can be accepted in the court system. Only by adopting these fundamental principles can legal experts effectively argue for the admission of forensic evidence, constructing a persuasive case that aligns with the concept of justice. In the courtroom, the influence of forensic justice enables legal professionals to structure cross-examination while exploring the competence of forensic specialists. Equipped with an understanding of scientific methodologies, the complex nuances of evidence dependability, and the risks of inherent bias, advocates use their intellectual acumen to contest the foundations of forensic evidence effectively. In this context, their comprehension ignites critical analysis, revealing the truth and exposing any concealed errors inside the criminal justice system (Roach 2009)

Techniques, rigorous standards, and intrinsic limits surrounding the field of forensic understanding the principles of forensic justice beyond the courtroom. It develops as a collaborative symphony, integrating forensic specialists and legal professionals in a cohesive partnership. This synergy, driven by mutual comprehension, enables an exceptional interpretation and presentation of forensic evidence to deliver justice. Armed with scientific expertise, legal professionals traverse the complicated domain of forensic science, connecting comprehension with the application of scientific ideas. Their combined efforts enhance the effectiveness of forensic evidence in promoting justice (Klingele, Scott, and Dickey, n.d.)

Each advancement in comprehending the foundations of forensic justice establishes a stronghold against the misunderstanding and manipulation of evidence. The diligent quest to understand scientific methods, the alluring limits of constraints, and the inherent biases within forensic procedures strengthen the protectors of justice against the influences of lies and deception. (Cooper, n.d.) The legal experts, committed to strict scientific standards and ethical principles, protect the integrity of forensic evidence. In their determined pursuit, they navigate the perilous avenues of examination, maintaining the integrity of justice and preventing potential erroneous convictions.

Beyond the desire for justice exists a domain where the principles of forensic justice converge with ethical dilemmas about forensic evidence. Legal professionals with a profound comprehension of fundamental ideas navigate a nuanced balance between integrity and ethics.

They rigorously evaluate the credibility and importance of forensic evidence, guaranteeing that only the most relevant elements are included in judicial processes. Ethical issues, including the avoidance of prejudices and the respect for individual rights, influence every choice they make. These experts serve as stewards of justice, dedicated to maintaining the principles of fairness and steadfast regard for human rights.

"Forensic justice," grounded in the principles of fairness and equity, corresponds with the foundational tenets of egalitarianism and the Law of Evidence. Forensic Justice requires strict adherence to laws, thereby improving accountability in the criminal justice system through the application of forensic procedures. (Renaud et al. 2021) Forensic Justice emphasizes the critical role of forensic science in upholding the principles of justice and establishing a mutually beneficial relationship between science and justice.

Forensic Justice is evident in Indian courtrooms, where DNA evidence, ballistics, fingerprint analysis, and toxicology reports play a pivotal role in numerous criminal trials. Indian courts have adjudicated numerous significant cases pertaining to forensic evidence. In Selvi v. State of Karnataka, the Supreme Court examined the admissibility of narco-analysis and polygraph tests, heavily referencing foreign jurisprudence, including the *U.S. Daubert and Frye standards*. In *Premjibhai Bachubhai Khasiya v. State of Gujarat*, the validity of DNA evidence was examined, leading the Court to determine that positive DNA results alone do not definitively prove guilt, whereas a negative DNA test can absolve the accused.

Forensics plays a crucial role in investigations that follow a crime. This process includes gathering and examining evidence from the crime scene, helping law enforcement build strong cases based on scientific information. The use of forensics in investigations faces many challenges, with the most notable being the unclear standards for what forensic evidence can be accepted in court.

Even with considerable progress in forensic science, many institutional obstacles prevent its full incorporation into the criminal justice system. These necessitate significant changes to legal frameworks, institutions, and procedures, enabling these matters to be classified as either post-crime applications or pre-crime interventions. Forensic science frequently remains underused in post-crime investigations due to slow evidence processing, a lack of proper forensic infrastructure, and poor coordination between law enforcement and forensic labs. Additionally, an important question relates to whether forensic evidence can be accepted in legal cases. Forensic evidence is frequently seen as objective and trustworthy; nonetheless, it needs to meet legal standards to be accepted in court. In India, the lack of a thorough legal framework frequently results in varying decisions about the admissibility of forensic evidence. Setting clear standards for scientifically valid forensic methods would help ensure that courts do not mistakenly dismiss credible evidence or accept unreliable evidence, potentially leading to wrongful convictions or acquittals. Secondly, in different areas, such as India, the investigation of pre-crime prevention using forensic intelligence and predictive policing has not been thoroughly explored. The Criminal Procedure (Identification) Act 2022 creates a legal structure for gathering biometric data. Nevertheless, a lack of technical know-how and proper infrastructure prevents law enforcement agencies from making the most of forensic intelligence to curb criminal activities. There are major concerns about how forensics is applied in pre-crime policies, particularly related to privacy issues and the possible misuse of forensic data, leading to serious ethical dilemmas.

This paper has tried to explore two problems, the insufficient use of forensic science in investigations after crimes occur and the absence of forensic intelligence in efforts to prevent crimes before they happen. Major changes are crucial in both forensic science and the criminal justice system to improve their effectiveness.

The Role of Forensic Science in Post-Crime Investigations

Forensic justice has the potential to transform the criminal justice system by offering evidence that is backed by empirical validation, which can improve both pre-crime prevention and post-crime investigations. Significant challenges remain, especially concerning the acceptance of forensic evidence in legal proceedings. This paper has attempted to investigate how forensic justice can transform the criminal justice system by incorporating forensic science into both post-crime investigations and pre-crime prevention, while also identifying the challenges that hinder the integration of forensics within the justice system. This paper provides a thorough comparison of forensic justice frameworks in the U.S., U.K., and India, emphasizing the previously mentioned gaps in jurisdictions and presenting specific recommendations for enhancing the application of forensic evidence in criminal trials. This paper explores and establishes forensic justice as a key element of the Indian legal system, enhancing the efficiency, accuracy, and fairness of court judgments.

Even with considerable progress in forensic science, many institutional obstacles prevent its full incorporation into the criminal justice system. These necessitate significant changes in legal, institutional, and procedural frameworks, enabling these matters to be classified as either post-crime actions or pre-crime prevention

strategies. Forensic science is frequently underutilized in post-crime investigations due to delays in processing evidence, a lack of sufficient forensic infrastructure, and poor coordination between law enforcement and forensic labs. Additionally, an important question centres on whether forensic evidence can be accepted in legal cases. Forensic evidence is frequently seen as objective and trustworthy, but it needs to satisfy legal criteria to be accepted in court. In India, the lack of a thorough legal framework frequently results in varying decisions about the acceptance of forensic evidence. Setting clear standards for scientifically valid forensic methods would help ensure that courts do not mistakenly dismiss reliable evidence or accept unreliable evidence, potentially leading to wrongful convictions or acquittals. Secondly, in different regions, including India, the investigation into pre-crime prevention via forensic intelligence and predictive policing is still mostly overlooked. The Criminal Procedure (Identification) Act 2022 sets up a legal framework for gathering biometric data. However, a lack of technical expertise and infrastructure is preventing law enforcement agencies from effectively using forensic intelligence to stop criminal activities. Several important concerns arise regarding the use of forensics in pre-crime policies, including privacy issues and the potential for ethical dilemmas stemming from the misuse of forensic data.

This paper explores a significant challenge: on one hand, the insufficient use of forensic science in post-crime investigations, and on the other, the absence of forensic intelligence in preventing crimes before they occur. To successfully utilize forensic science in rejuvenating the criminal justice system, substantial modifications are necessary in both domains.

Initially, the incorporation of forensics into the criminal justice system is a complex idea that includes various fields such as DNA analysis, fingerprint examination, toxicology, ballistics, and digital and cyber forensics. Forensics plays a pivotal role in the post-crime investigation by collecting and analysing evidence at the crime scene, which assists enforcement agencies in building solid cases based on scientific evidence. Yet the application forensic in investigation is fraught with multiple issues one of most crucial being the unsettled standards of admissibility of forensic evidences in the courtroom.

In the United States, jurisprudence surrounding the admissibility of forensics evidence has evolved through a series of landmark rulings that established criteria for the admissibility of expert testimony and scientific evidence. Mainly in three cases *Frye v. United States (*1923)*, Daubert v. Merrell Dow Pharmaceuticals Inc (*1993), *and Kumho Tire Co. Ltd. v. Carmichael (*1999) the United States Supreme Court has stood out in crafting comprehensive rules on how the judiciary must assess the reliability of forensic evidence.

The *Frye* case marked the first significant judicial attempt to regulate scientific testimony in the courtroom. Frye dealt with a systolic blood pressure deception test, a crude predecessor to the polygraph. In 1923, this blood pressure test was not widely accepted among scientists, so in the Frye case, the court ruled it could not be used in court. In this case, the court established what became known as the *"general acceptance"* standard, holding that scientific techniques must be sufficiently established and accepted by the relevant scientific community to be admissible in court. This rule dominated the admissibility of forensic evidence for decades but was criticised for being overly restrictive; much after the Fyre case, the *Daubert* ruling fundamentally reshaped the U.S. forensic jurisprudence by moving away from the rigid *Frye* standard. In this case, a drug was in question for its alleged side-effect on the child in the womb, thereby causing deformities, the United States Supreme Court ruled that scientific evidence must be relevant and reliable, providing trial judges with a gatekeeping role. This role involved evaluating factors such as whether the theory or technique could be tested, whether it had been peer-reviewed, its known or potential error rate, whether there are recognised standards that control the procedure of implementation of the technique, whether it enjoyed general acceptance from the community and whether the technique has been introduced or conducted independently of the litigation. This more flexible, case-by-case approach allowed for the inclusion of emerging scientific methodologies, making the legal system more adaptive to advancements in science and technology.

The Kumho Tire ruling broadened the principles set forth in Daubert to encompass not just scientific evidence, but also technical and specialized knowledge. The expert testimony in this instance was not based on hard science, but instead relied on specialized knowledge regarding tyre failure. The Court determined that the judge's role in overseeing expert evidence is consistent across all types, guaranteeing that both technical and experiential insights are held to the same strict reliability criteria as scientific evidence.

In the United Kingdom, the framework for admitting forensic evidence holds great importance, rooted in the case of *R v. Turner (1975),* which scrutinized the admissibility of expert opinions. British courts have adopted a more organized method for handling forensic evidence, guided by legislation such as the Criminal Procedure Rules (CrimPR 2020), mandating that courts assess the reliability of expert evidence. The case of *R v. T (2010)* changed the way footwear impression evidence is viewed, highlighting the robustness and dependability of forensic methods.

The structured approach in the U.K. guarantees that forensic evidence is carefully examined for its scientific reliability and its relevance to the case, thereby minimizing the chances of wrongful convictions or misinterpretation. The Criminal Procedure Rules require forensic experts to adhere to certain competency standards, ensuring that their testimony is based on reliable scientific methods. This method provides important insights for India, where the lack of such guidelines has led to varying judicial results.

The U.S. has established clear standards for the admissibility of forensic evidence, whereas the Indian legal system is still in the process of development. Indian courts are turning to forensic evidence more frequently in both criminal and civil cases. However, the lack of a standardized framework for its admissibility and evaluation has resulted in inconsistencies. The judiciary has addressed the standard for admitting forensic evidence in various cases. One of the initial instances where the Allahabad High Court looked into the criteria for admitting forensic evidence was in the case of *Mr. Titli v. Alfred Robert John (1934).* In this case, the Hon'ble Court stated that "expert evidence is admissible only when it can provide insight into issues that lie beyond the average understanding of the judge or jury." This case, decided in 1934, continues to hold significance today as it illustrates the careful stance that Indian courts adopt regarding forensic evidence, emphasizing its necessity and reliability. The Supreme Court reaffirmed the ratio of Titli cases in 1999 during the case of *State of HP v. Jai Lal.* A notable case emerged after ten years, where the court in *Malay Kumar Ganguli (2010)* carefully assessed the reliability of medical experts' testimony and highlighted the necessity of examining such evidence to prevent miscarriages of justice. The most crucial ruling in this regard came in the case of *Ramesh Chandra Agrawal v. Regency Hospital Ltd* (2010). This case involved a claim of medical negligence, where expert testimony played a pivotal role in determining whether the healthcare professionals in question had breached the required standard of care. The Supreme Court of India emphasized the importance of expert evidence in cases where the issues extend beyond the knowledge and experience of a lay-person and laid down eight rules of admissibility, namely;

(i) The first and foremost requirement for expert evidence to be admissible is that it is necessary to hear the expert evidence. The test is that the matter is outside the knowledge and experience of the layperson.

(ii) The expert must be within a recognized field of experience

(iii) The evidence must be based upon reliable principles.

(iv) The expert must be qualified in the particular discipline.

(v) It must be shown that the expert has made a special study or acquired a special experience in the subject.

(vi) The expert must place before the Court all the materials, together with his reasons for coming to the particular conclusion.

(vii) Expert evidence is really of an advisory character

(viii) The duty of an expert is to furnish the judge with the necessary scientific criteria for testing the accuracy of the conclusions and enabling the judge to form his independent judgment by applying these criteria with facts proved by evidence of the case.

However, the case also exposed procedural inefficiencies, such as delays in obtaining expert opinions, hampered the effective use of forensic evidence in the judicial process. Further, the lack of training of law professionals in understanding the scientific data and evidences exacerbates issues of admissibility.

The introduction of the Criminal Procedure (Identification) Act 2022 marks a significant step forward in expanding the scope of forensics in the criminal justice system by allowing the acquisition of biometric data from a broader pool of individuals, including convicts, arrestees, and detainees. The recent enactment of the new criminal laws, Bhartiya Nyaya Sanhita, 2023, Bhartiya Nagarik Suraksha Sanhita, 2023, and Bhartiya Sakshya Adhiniyam, 2023, marks a transmuting stage in the Indian criminal justice system, as they integrate the science and technology within the criminal justice system. Section 176 (3) of BNSS mandates the forensic investigation of the offences, which is punishable for seven years or more, exponentially increasing the use of forensics. In India's criminal justice system, forensic intelligence offers the potential to address the chronic delays, inefficiencies, and case backlogs that plague investigations and prosecutions. A glance into the crime statistics of NCRB reveals that from 2018- to 2022, 23,24,422 offences were reported, which were punishable by more than seven years; with the implementation of new laws that foster the framework for forensic justice, it becomes imperative to standardised admissibility of forensic evidence.

The advent of technology and the advancement of forensic capabilities not only offer post-crime investigation aids but have the potential to facilitate the prevention and prediction of crime through forensic intelligence. The essence of forensic intelligence lies in expediting the actionability of data, ensuring that results are promptly delivered to inform law enforcement decisions. Pattern recognition and criminal profiling through the identification of behavioral tendencies can enhance predictive policing, aiding in identifying crime hotspots and facilitating early interventions by law enforcement agencies. Still, in numerous jurisdictions, including India, forensic justice has not fully realized its potential in crime prevention, investigation, and prosecution.

Further, integrating forensic expertise with predictive policing has demonstrated efficacy in multiple jurisdictions for crime deterrence. Predictive policing algorithms can supposedly analyse crime data and forensic evidence to forecast potential criminal activity. Enabling enforcement agencies to allocate resources and prevent crimes proactively and judiciously. The latest Criminal Procedure (Identification) Act, 2022, has expanded the scope for collecting biometric data, including fingerprints, DNA, and iris scans, for potential use in pre-crime investigations in India. Collecting and using forensic data for pre-crime prevention raises substantial ethical and legal concerns, particularly regarding privacy. The utilisation of forensic data for pre-crime analysis must be balanced against the fundamental right to privacy recognised in India by the landmark ruling in *Puttaswamy v. Union of India (2017).*

Forensic Intelligence and Crime Prevention
The evolution of policing strategies and new technologies has significantly expanded the role of intelligence in law enforcement agencies. Despite the challenges of extending former community-based and problem-oriented (Goldstein, 1990) philosophies beyond specific experiments (Brodeur, 1997), intelligence is now widely acknowledged to play an important role in both diagnosing insecurity problems and designing targeted, preventative actions (Gottlieb, 1998). The strategic allocation of resources to the most pressing problems, as well as the measurement of police performance (primarily through crime reduction indicators), provide additional managerial motivation for improved intelligence-based policing approaches.

The creation of crime analysis units within police organizations has contributed to intelligence's increased role. However, the implementation of these new structures has occasionally faced opposition. It is not always clear why the police should broaden their role when there are often insufficient resources to carry out their traditional duties. Ideologically, the new strategies can be interpreted as reducing the importance of individual investigations and, as a result, changing the investigator's role. Furthermore, it allows civilian employees to join the confined police community. Finally, crime analysis is a transversal process that cuts across vertical hierarchies, favoring obedience to traditional hierarchical demands while responding to demands from other colleagues or services in a low priority order. These may be exacerbated by traditional boundaries jealously guarded as specialist fields of expertise.

As a result of this background, crime analysis has attracted researchers from various academic fields, including geography, psychology, and criminology. Their work has given the domain an impressive collection of models, methods, and computerized tools (Gottlieb, 1998; McGuire, 2000; Peterson, 2000). Furthermore, ideas about the connections between criminal intelligence analysis and specific bodies of scientific knowledge are emerging in the literature, such as in the field of psychological profiling (Atkin, 2002).

Forensic scientists have also participated in the debate, primarily through the development of databases (Sprangers, 1997), but also through crime reduction projects and research programs that encourage increased utilization and awareness of forensic seizure among all contributors to the criminal justice system (FSS, 2000; NIFS, 2002). This shift in attitude has resulted in increased funding, significant technological advancement, and specific successes in crime solving. For example, innovative database applications enable new forms of intelligence that were previously unimaginable or simply prohibited by legal constraints (Anonymous, 2002). However, while recent advances enable forensic intelligence to better assist police in specific criminal cases, there is still a lack of understanding of how to go beyond traditional identification, such as through DNA or AFIS databases (Walsh et al., 2002).

Forensic science research suggests using traces such as shoemarks and geographical information to link crime scenes (Birkett, 1989; Milne, 2001; Napier, 2002). These approaches help to close the gap between forensic science and evidence analysis, but they do not make this intention explicit. Intelligence-led policing tempts forensic science to operate in a new context in which it has yet to establish itself (Walsh et al., 2002).

Previously (Ribaux & Margot, 1999, submitted), proposed a framework for crime analysis that incorporates all forensic case data. The argument then was that this conceptual model should be based on two main components:

- A structured memory that represents the knowledge we have about the criminality at a given time: current problems, active series, linked cases, and so on (basic intelligence).
- A structured repertoire of systematically, frequently, or possibly applied inference structures that demonstrate how to combine the use of various types of data during the analysis.

This framework aids understanding of the relationships between forensic science and crime analysis, the design of specific intelligence processes and computerized systems, the interpretation of new situations in light of what is already known, and the integration and organization of knowledge resulting from these new experiences. It also provides an opportunity to start a debate about memory management and uncertainty treatment.

The concept of intelligence will be recalled and applied to the forensic setting.

A review of traditional inference structures used with forensic databases will follow. Finally, we show how innovative inference structures can improve our current collection. The examples provided have been successfully applied in actual cases and have a high potential for systematic exploitation as a crime analysis technique. Intelligence is commonly defined as the timely, accurate, and usable result of logically processed information. In the criminal justice system, the information relates to crime and the context in which it occurs. For example, based on a series of crimes, available data can sometimes be used to form a hypothesis about where the criminal lives or when and where he will commit his next crime. These judgments provide leads, which are then converted into operational measures such as surveillance or targeted police patrols.

This interpretation step, known as analysis, is frequently regarded as the heart of a process that encompasses the entire treatment of data, from collection to practical implementation of the intelligence itself ('the intelligence process'; Peterson, 2000). Criminology, computer science, psychology, forensic science, and economics can all contribute to an analysis. Reasoning on imperfect information (which is systematically uncertain, incomplete, imprecise, or even contradictory) can spark heated debate, particularly in domains where inferences are carefully studied and discussed with the goal of providing intelligence through well-founded criminal investigation methods. However, a lot of effort is generally dedicated to the construction of elaborate formalisms, whereas the accuracy of the results in the real context of the investigation can vary greatly. The practical benefit of these research activities can be difficult to assess and even questionable, as with some psychological approaches (Beauregard & Proulx, 2001; Santtila et al., 2003).

Contributions from specialized domains are frequently viewed as a supplement to crime investigation, with the implicit assumption that the intelligence will be integrated through well-defined investigative frameworks. Criminal investigations are typically informal and rely on common sense (Kind, 1987; Ribaux et al., 2002). Criminal intelligence analysis involves integrating data and specialized knowledge to improve investigative processes and effectively communicate results to partners. By definition, forensic science serves as an intermediary between specialized fields of science and law enforcement. To reiterate our earlier definition, forensic intelligence is the accurate, timely, and useful result of logically processing forensic case data. The implications of an additional level of consideration are significant, as the results of forensic analyses become the source of intelligence when viewed collectively (across multiple investigations or disciplines).

Forensic intelligence has transformed criminal investigations within law enforcement. For decades, traditional forensic science has supplied essential evidence to aid in crime resolution and ensure convictions. Its application has been responsive, concentrating on post-crime evaluation (Houck, 2020). The intricate nature of contemporary crime, encompassing organized crime, cybercrime, and transnational crime, necessitates a proactive, intelligence-led strategy (Delgado et al., 2021). The extensive data produced in the digital era complicates real-time analysis for numerous conventional forensic science tools, requiring effective solutions (National Institute of Justice [NIJ], 2022).

Forensic intelligence transforms forensic data into actionable insights to facilitate crime resolution, prevention, and the expeditious administration of justice (Delgado et al., 2021). This procedure amalgamates forensic data from DNA, fingerprints, ballistics, and digital forensics with sophisticated data analytics and artificial intelligence to rapidly acquire insights during investigations. The proactive utilization of forensic data enables law enforcement to discern patterns, connect ostensibly unrelated crimes, and anticipate criminal behaviour (NIJ,2022).

Forensic intelligence systems operate worldwide. The Combined DNA Index System (CODIS) and the National Integrated Ballistic Information Network (NIBIN) assist U.S. law enforcement in resolving intricate and transnational cases by correlating forensic evidence across jurisdictions (Lopez, McGrath, & Taylor, 2020). In accordance with the Criminal Procedure Rules, the UK incorporates forensic data systems into the intelligence framework. This integration establishes forensic intelligence as fundamental to investigations and prosecutions from the outset (UK Home Office, 2020). These examples demonstrate how forensic intelligence systems enhance case resolution, diminish wrongful convictions, and optimize law enforcement resource allocation (Houck, 2020).

The incorporation of forensic intelligence into India's criminal justice system transcends mere technology. Law enforcement, the judiciary, and policymakers must reevaluate forensic data. When thoroughly analyzed, forensic data can forecast criminal patterns, identify suspects, and mitigate investigation delays (Indian Ministry of Home Affairs, 2022). The implementation of forensic intelligence tools such as Automated Multi-modal Biometric Identification Systems (AMBIS) and forensic data within platforms like Crime and Criminal Tracking Network & Systems (CCTNS) demonstrates that India can embrace an intelligence-driven methodology in policing.

The United States and the United Kingdom offered insights. Offer significant perspectives on the incorporation of forensic intelligence within India's criminal justice framework. The U.S. NIBIN platform connects ballistic evidence from various cases, assisting law enforcement in resolving unsolved crimes (National Institute of Justice [NIJ], 2020). CODIS has revolutionized DNA evidence in criminal investigations, linking unresolved cases across states and mitigating recidivism (Lopez, McGrath, & Taylor, 2020).

Forensic intelligence systems in the UK collaborate closely with intelligence-driven policing. The Criminal Procedure Rules (CrimPR) underscore the significance of forensic data in pre-trial procedures to examine and authenticate evidence prior to court proceedings (Crown Prosecution Service, 2022). The utilization of forensic data has significantly diminished unresolved cases and enhanced conviction rates. Adapting these models for India can render forensic intelligence a significant asset in enhancing the country's criminal justice system.

Forensic intelligence serves to deter criminal activity, which is its primary advantage. Conventional forensic science aids in the resolution of historical crimes, whereas forensic intelligence assists law enforcement in crime prevention. Forensic data analysis assists law enforcement in identifying crime hotspots, forecasting future offenses, and optimizing resource allocation (Delgado et al., 2021). Forensic intelligence systems in Chicago and Los Angeles forecast gang violence hotspots, enabling law enforcement to intervene prior to the escalation of crime.

India's challenges with terrorism, organized crime, and human trafficking necessitate forensic intelligence. Crimes frequently encompass various jurisdictions and intricate offender networks. Forensic intelligence systems and national databases such as CCTNS enable Indian law enforcement to monitor suspects across state boundaries and dismantle criminal networks prior to the execution of their schemes (National Crime Records Bureau [NCRB], 2022).

Integrating forensic intelligence into India's criminal justice system can enhance investigations, alleviate case backlogs, avert wrongful convictions, and deter future crimes. This paper has utilized global best practices and analyze India's legislative framework to propose pragmatic forensic intelligence solutions.

Forensic intelligence enhances law enforcement's utilization of forensic data to resolve and avert criminal activities. Forensic science has conventionally been reactive by gathering and examining evidence post-crime. This approach streamlines judicial procedures but is inadequate for proactive crime detection, prevention, and real-time investigation. Contemporary criminal justice systems have evolved through the integration of forensic intelligence, which merges forensic science with data analytics and intelligence-led policing (Houck, 2020).

Forensic intelligence is a proactive, intelligence-driven function within law enforcement, as opposed to reactive forensic science. Conventional forensic science gathers and examines evidence to assist in crime resolution and to validate or refute suspects. This reactive strategy is inadequate in light of the proliferation of organized crime, cybercrime, and transnational criminal networks. Forensic intelligence, as stated by Delgado et al. (2021), entails the amalgamation of forensic science and data analytics to support investigations, inform decision-making, and mitigate crime escalation.(Delgado et al., 2021).

In the United States, the Combined DNA Index System (CODIS) and the National Integrated Ballistic Information Network (NIBIN) demonstrate the utility of forensic intelligence in assisting law enforcement to connect crimes across various locations. These systems can rapidly cross-reference forensic data to identify serial offenders or resolve cold cases. CODIS has effectively connected sexual assault cases across states, assisting authorities in identifying recidivists and resolving unresolved cases. NIBIN correlates ballistic data from multiple crime scenes, frequently identifying links between ostensibly unrelated events.

Intelligence Analysts (IA) are becoming progressively vital as forensic intelligence evolves. Artificial intelligences convert intricate forensic results into practical intelligence that can inform ongoing investigations, as stated by Delgado et al. The transition from back-end to front-end forensics necessitates the amalgamation of forensic science and intelligence analysis. The National Institute of Justice (NIJ) framework for integrating forensic intelligence into law enforcement is based on Organization, Process, Technology, Capabilities, and Information Sharing. These pillars facilitate the effective transmission of forensic data from collection to actionable intelligence, supporting law enforcement investigations and crime prevention. The Organization pillar underscores the importance of forensic intelligence leadership and well-defined roles. To optimize the forensic intelligence system's efficacy, forensic scientists, intelligence analysts, and police investigators must comprehend their roles and responsibilities. Workflows for data collection, analysis, and dissemination are standardized to facilitate the systematic use of forensic information across various cases. The Technology pillar underscores the necessity for contemporary infrastructure to facilitate rapid forensic analysis. Preliminary investigations necessitate automated real-time data processing systems to convert forensic intelligence into actionable insights. Capabilities focus on cultivating the expertise, resources, and training essential for forensic intelligence initiatives, whereas Information Sharing underscores collaboration and communication among agencies. The NIJ framework guarantees that forensic intelligence supports post-crime inquiries and proactive law enforcement efforts.

Houck (2020) advocates for front-end forensics, which would revolutionize forensic science. Courtrooms have conventionally utilized forensic data to substantiate prosecutorial evidence. Front-end forensics prioritizes the early utilization of forensic data in investigations. This approach assists law enforcement in generating leads, connecting crimes, and averting escalation.

According to Houck, front-end forensics is crucial in regions characterised by elevated rates of gun violence, sexual assault, and burglary. Forensic intelligence has enabled the Miami-Dade Crime Gun Intelligence Center (CGIC) to connect firearm-related crimes in real time, facilitating the apprehension of suspects prior to additional offenses. This advanced application of forensic data targets specific crimes and disrupts criminal networks by early identification of patterns.

Forensic intelligence operates effectively in the U.S. and U.K., yet India encounters distinct challenges. The Criminal Procedure (Identification) Act, 2022, in India permits the acquisition of fingerprints, DNA, and iris scans. This legislation enhances forensic data collection; however, in the absence of a robust forensic intelligence framework, a significant portion may remain unutilized. Inadequate funding results in forensic data analysis backlogs in Indian laboratories. Law enforcement encounters difficulties in utilizing forensic data in investigations owing to systemic challenges.

In the absence of real-time forensic intelligence systems such as CODIS or NIBIN, India analyzes forensic data post-incident rather than engaging in proactive investigations. The amalgamation of CCTNS and NCRB into a national forensic intelligence system remains unfinished, constraining law enforcement's capacity to disseminate forensic data across jurisdictions. Forensic intelligence cannot achieve its maximum potential without integration.

The collection of biometric data presents ethical and privacy issues in the context of India's Right to Privacy ruling from *Puttaswamy v. Union of India*. Forensic intelligence must meticulously assess the collection, storage, and utilization of biometric data to safeguard privacy.

The collection and utilization of biometric data present significant ethical dilemmas as forensic intelligence advances. As forensic intelligence systems advance, apprehensions regarding data misuse escalate. The *Puttaswamy case* demonstrates that forensic intelligence systems must adhere to privacy and data protection regulations. Law enforcement agencies and forensic laboratories must implement protocols for the sharing and utilization of biometric data.

The forensic intelligence legislation in India must mitigate the risks associated with data misuse. In the absence of safeguards, data may be utilized for non-criminal purposes, infringing upon civil liberties. As forensic intelligence becomes increasingly integrated into law enforcement, these ethical concerns will intensify.

The literature on forensic intelligence highlights its potential to transform the criminal justice system. Delgado and Houck demonstrate that the incorporation of forensic data into expedited decision-making enhances investigations, mitigates crime, and advances justice. Forensic intelligence in India necessitates significant infrastructural and institutional reforms. The Criminal Procedure (Identification) Act, 2022, represents advancement; however, it requires a robust forensic intelligence framework for optimal efficacy.

India must prioritize the enhancement of its forensic laboratories, the integration of national crime databases, and the establishment of ethical guidelines for biometric data. Indian forensic intelligence can enhance its capabilities by adopting international frameworks such as CODIS and NIBIN, which facilitate criminal investigations and crime prevention. Forensic intelligence will increasingly play a crucial role in facilitating prompt, and equitable justice.

Institutional and Procedural Challenges in India

The primary objective of all laws is to provide justice for humanity, which is fundamentally grounded on truth, impartiality, independence, and the skill of those tasked with upholding law and order and administering justice. Assistance in achieving justice from any discipline, whether it be history, philosophy, social science, or science and technology, is always appreciated. It is widely accepted that science and its methodologies are fundamentally accurate and precise, since they are grounded on observable physical realities (Bowers, 2010). Science has existed since ancient times; but, in past century science and technology were mostly autonomous endeavours, without interconnection.

Frequently, centuries or decades would pass before a scientific concept could be practically applied. Engineering evolved mostly independently of science, being influenced by experience and tradition (Katju, 2018). In the contemporary era, science and technology have become intricately interconnected, significantly reducing the gap between them. This convergence has been further enhanced by the emergence of various disciplines such as chemical sciences, biological sciences, and forensic sciences. Consequently, it is unequivocally accurate to assert that this modern age is characterized by science and technology, devoid of any skepticism (Breyer, 1998). The role of forensic science has become essential in the investigative process undertaken by the Investigation Officer of any crime and for establishing facts. Nevertheless, while one may

be persuaded of the precision of science in revealing the veracity of any factual matter under scrutiny, especially in criminal cases, this perspective is not mirrored by courts globally, which do not depend as heavily on scientific methods as anticipated by the general populace and the scientific community (Shipley & Arrigo, 2012).

Michael Bowers said, "Numerous forensic science disciplines, once regarded as reliable, have faced criticism for relying on false assumptions, inadequate science, flawed techniques, and incorrect interpretations." Regrettably, several complaints have shown to be valid and well-founded. Essential to this is comprehending how the scientist's results may be accurately understood, assessed, and conveyed to the court and how the court derives suitable conclusions from the expert testimony to arrive at its conclusion on the fundamental question. The court must ensure that the science is genuine and that the evidence is relevant to its considerations (Katju, 2018).

Despite the longstanding incorporation of the notion of relevance into legal frameworks across several countries, contemporary inquiries have arisen globally about broader facets of the presenting of scientific evidence in court and the function of the scientist as an expert witness (Breyer, 1998). Numerous factors, including substantial advancements in scientific methodologies, the necessity for investigators to address increasingly intricate and high-profile offenses, heightened scrutiny of these issues, and the continuous reactions of the legal profession and legislators to these developments, contribute to the skepticism surrounding scientific findings and their standing in a court of law. What constitutes scientific knowledge, and under what circumstances is it deemed reliable? These ostensibly straightforward issues have been a subject of perpetual dispute. In the courts, the resolutions of criminal, paternity, environmental, and medico-legal matters sometimes hinge on scientific evidence, the credibility of which may be vigorously disputed. Researchers have debated for years over the hazards or lack thereof associated with radon in residential environments, stilbestrol residues in food, and other possibly subtle sources of harm.

Justice Markandey Katju, a distinguished judge of the Supreme Court of India, said in his book that *"Every institution is fundamentally comprised of the personnel that operate it; thus, a High Court is not merely an aesthetically pleasing edifice or landscaped grounds, but rather the judges who staff the institution."* Consequently, they need to be individuals of esteemed reputation and honesty in their behavior, complemented by the legal expertise they have acquired.

The rationale is straightforward. The legal challenges presented to us increasingly pertain to the principles and methodologies of science. The appropriate settlement of these issues is significant not only for the litigants but also for the broader public, who reside in our technologically intricate society and whom the law is obligated to serve. Our judgments must include a sound scientific and technological comprehension to ensure that the legislation addresses public requirements. Nevertheless, it is also accurate that not all judges can excel in every domain of social life, including scientific inquiry and criminal investigation.

Judicial tribunals globally exhibit significant caution over the admission of scientific evidence, particularly expert judgments, in light of the expanding body of scientific knowledge. The sometimes unprofessional and unpersuasive, and in certain cases intentionally misleading presentation of scientific testimony often leads to a court's rejection of it as evidence. Similarly, the excessive caution or the inherent incapacity of a judge, whether stemming from a personal deficiency in scientific knowledge or from legal constraints, to comprehend the significance and relevance of scientific evidence—even when adequately presented—frequently results in the unjustifiably delayed acknowledgment of a scientific principle or its application.

Forensic science in criminal investigations and prosecutions primarily focuses on materials and, by extension, on individuals, locations, and temporal aspects. The investigating officer is the most significant individual among males. Ultimately, it is he whose efforts dictate the efficacy or ineffectiveness of forensic science in the context of criminal proceedings. If he fails to gather the pertinent and accurate evidence, or permits it to be contaminated, altered, switched, or destroyed, or does not supply proper samples for comparison in forensic laboratories, the forensic scientist's findings will not only be ineffectual; they may also be deceptive and potentially assist the perpetrators.

On a positive side, scientific tools and procedures facilitate the identification and comparison of materials. They determine the existence or nonexistence of a connection between the crime and the perpetrator, the victim, the weapon used, etc.

The Indian judicial system seems to possess an advantage over the U.S. courts due to the absence of established parameters or standards set by the apex court, thereby providing an expanded jurisdiction. However, this also introduces a degree of ambiguity, as most courts primarily depend on the principles of justice, equity, and good conscience. Nevertheless, this method becomes almost impracticable in complex instances where the judge must depend only on scientific evidence and expert testimony.

Numerous institutional and structural issues pertain to the admission of scientific evidence in legal proceedings. Certification criteria for crime data analysts and quality assurance procedures for forensic science facilities,

especially those solely focused on criminal data analysis, are often essential prerequisites in Indian courts. The need for the use of science in the administration of justice is urgent. Factors necessitating the broad use of science in both investigative processes and courtrooms include societal change, the need for speedy and precise evidence, and the reconstruction of crime scenes. Indian society is experiencing significant social transformation at an accelerated pace. A substantial industrial complex has emerged in almost all regions of India, whereas rural areas are seeing a downturn. The outcome is multifaceted, encompassing advancements in modern rapid transportation and medical sciences, such as plastic surgery and blood transfusion, on the technical side, while simultaneously reflecting a rise in domestic violence cases and the prevalence of nuclear families, which are frequently susceptible to crime, on the social side. The perpetrator, after executing the act in any of these locations, may flee to an undisclosed region conducive to evasion from the crime scene. Contemporary communication methods are exceedingly advantageous for crooks. Satellite communication has been used by these criminals, not just for perpetrating crimes domestically but also internationally. However, the same approaches may be used by crime detectives to efficiently hunt down offenders. As contemporary modes of mobility grow rapid and efficient, perpetrators often evade legal authorities by eluding law enforcement organizations.

Appraising the handling of forensic evidence within the criminal justice system and proposing proposals for change necessitates a first definition of the term "forensic evidence." Forensic evidence refers to information obtained via scientific disciplines or methodologies to investigate and substantiate criminal activities. Forensics, also known as 'criminalistics', significantly influences the dynamics of the criminal justice system. The resurgence of science and technology has significantly transformed conventional evidence collecting techniques, resulting in the discovery of offenders being mostly technology-driven. The influence of scientific and technical progress necessitates careful evaluation on the alignment of forensic evidence with the principles of evidentiary law.

Conclusions

Effective implementation of forensic sciences determines the strength of the whole system. The State aims to speed up regulation of the forensic sciences and it's allied disciplines to accommodate increasing demand for the same. However, policy-making cannot solve the issues encountered by forensic science labs in India until systemic flaws are evaluated using scientific data. Governments constant efforts and endeavours systematically regulate the FSLs are proving very effective. Legislative and supervisory inadequacies need to be addresses to avoid and remedy the fragmented structure of public and commercial forensic labs, leading to cost duplication and the emergence of unnecessary, uncontrolled, and ill-equipped facilities. Forensic labs face significant differences in service quality, financing, personnel availability, and certification. Current laboratory practitioners confront high workloads, bureaucratic challenges, and lack established protocols to govern their work. This has led to widespread mismanagement of scientific evidence, inaccurate data records, unhappy workers, untrustworthy expert testimony, and outmoded research methods.

After analyzing these issues, it's clear that India's forensic science ecosystem is not flawless. The Legislature should employ best practices from other countries' experience and avoid seeing forensic regulation as a faultless process. Future regulation and systemised framework models should include the particular developmental demands of each laboratory based on significant scientific study. A public-private paradigm that prioritizes laboratory independence while recognizing the necessity for external monitoring must be set up. Revamping Indian forensic justice framework via a participative approach with major stakeholders is a promising proposal. This is a positive start towards improving the criminal justice system, which is currently still at a nascent stage.

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