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The Use of Forensic Evidence in Criminal Proceedings: Assessing Reliability and the Need for Reform

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ABSTRACT

Forensic evidence has become indispensable in modern criminal proceedings, offering scientific methods to establish guilt or innocence. Its significance lies in enhancing the accuracy of fact-finding, strengthening prosecutorial strategies, and providing courts with reliable bases for judgment. However, concerns regarding its reliability, misuse, and susceptibility to human error and systemic deficiencies have led to wrongful convictions and miscarriages of justice. This paper critically examines the reliability of forensic evidence in criminal trials, with a particular focus on Pakistan's criminal justice system, while drawing comparative insights from other jurisdictions. It argues that although forensic evidence plays a pivotal role, reforms are urgently needed to ensure its consistent, transparent, and scientifically valid application.

Keywords: *Forensic Evidence; Criminal Proceedings; Reliability; Reform; Wrongful Convictions; Pakistan; Comparative Law; Criminal Justice*

INTRODUCTION

The place of forensic evidence in the modern criminal justice systems has become a necessity where it has fundamentally changed how the criminal justice players perceive guilt and innocence. Oratory evidence, circumstantial data and confessions were the type of evidence that ruled the adjudicative process until recently. Empirical methodologies, such as DNA profiling, fingerprint analysis, ballistics, toxicology and digital forensics, have brought a new era where evidentiary frameworks have changed back to a more scientifically grounded approach. These advocates argue that this kind of forensic input improves judicial accuracy, reduces miscarriages of justice, and strengthens the belief of people in the legal order.

However, the dependability of forensic evidence has received unswerving criticism. The history of empirical studies has recorded cases of inadequate methods, unclear procedures, and lack of competence in the specialists leading to inappropriate convictions. Such a vivid example is the Innocence Project of

the United States, which has recorded many cases when the post-conviction DNA test has freed the person, revealing the underlying systemic weaknesses in the dependence on inaccurate forensic methodology (Findley, 2017). Similarly, the National Academy of Sciences (NAS) in its landmark report in 2009 suggested that most of the disciplines used in the forensic field could not be scientifically validated and thus raised doubts on their evidentiary value in criminal cases (Koehler et al., 2023a).

The role of forensic evidence has been accorded increased statutory and judicial recognition in Pakistan especially after the creation of organizations like the Punjab Forensic Science Agency. However, significant challenges still remain in the area of infrastructure, professional training, resource distribution, and understanding of scientific findings by the judiciary. As a result, the Pakistani courts have sometimes found it difficult to strike the right balance between the promise of the forensic methodology and the practical limitations of its application (Ajmal & Rasool, 2022a).

As shown by comparative jurisprudence, the dependability of forensic evidence is not limited to technical aspects, but it extends to such areas as policy, governance, and legal reform. To use an example, the Criminal Procedure Rules in the United Kingdom require expert testimony to be of a high degree of reliability, and the United States adopts the Daubert model to determine admissibility (Bakhtiar, 2023). In contrast, Pakistan is yet to have such a comprehensive evidentiary framework to govern the scientific plausibility of forensic submissions and therefore still provides a lot of room to the judicial discretion.

Based on this, the paper considers two closely connected questions: how far can forensic evidence be called reliable in criminal proceedings and which reforms are necessary to allow its adequate integration into the criminal justice system of Pakistan? The comparative approach will help to highlight local shortcomings and guide the study based on the experience of other jurisdictions, which is why it is enlightening.

CONCEPTUAL FRAMEWORK OF FORENSIC EVIDENCE

In its loosest meaning, forensic evidence means using science and science-based methods to the resolution of legal cases. It covers a broad spectrum of skills including biological investigations like DNA and hematology, ballistics tests, handwriting tests, cyber forensics of digital data and chemical tests. The premise that underpins it is that empirical methodologies have the ability to objectively determine facts that are relevant to criminal proceedings and thus help courts to deliver just results. In comparison with oral testimony, which can be inaccurate and influenced by subjective effect, forensic evidence is considered as traditionally more reliable because it depends on the impact of empirical procedures, and reproducible procedures(Roberts, 2023).

Basically, forensic science is a point of contact between the empirical sciences and the legal field. The legislation is based on certainty and finality, but scientific practice is more inclined to probabilistic constructions and parameters of margin-of-error. Such inherent tension requires the existence of a conceptual framework which outlines the role of forensic science in legal settings. Researchers indicate that forensic evidence may not be interpreted as absolute evidence, but it can be viewed as a professional evidence, which is subject to admissibility, credibility, and cross-examination just as other types of evidence are. (Koehler et al., 2023b).

Forensic evidence is heterogeneous spectrum, and the modalities have different levels of scientific validation. DNA profiling is generally regarded as gold standard, due to its accuracy and high statistical power (Meintjes-Van der Walt & Dhliwayo, 2021). Conversely, modalities like hair microscopy, bite-mark analysis, and some methods of fingerprint have been criticized in light of their lack of empirical basis, and may be controversial to admit in some jurisdictions (Morgan, 2023). This heterogeneity is

important because it is clear that forensic evidence does not exist at any point, but there is a continuum of reliability dependent on the scientific field of origin.

Legally the forensic evidence follows the rules of evidentiary which governs the admissibility of the evidence. The Daubert standard provides that in common-law countries, such as the United States, expert evidence must be relevant and reliable, judged by such factors as peer review, known error rates, and general acceptance in the scientific community (Gvozdenovic, 2022a). In civil-law jurisdictions, in contrast, forensic evidence is frequently evaluated on the basis of wider principles of judicial discretion and proportionality. The evidenced-based system of the Pakistani jurisdiction is based on the Qanun-e-Shahadat Order 1984 that recognizes expert testimony, but has not yet established a detailed codified guideline on the admissibility of scientific evidence, thus allowing the judiciary to exercise significant interpretative powers (Abbasi et al., 2021).

The conceptual framework also requires us to acknowledge the importance of institutions in making forensic science to be reliable. The competence of the laboratories, the impartiality of the experts, and the mechanisms of oversight and accreditation bear a huge responsibility in the forensic methods, yet all these are scientifically valid. In the absence of institutional integrity, even the most scientifically valid methods can be used improperly, which has a negative impact on the validity of forensic evidence in the court (Galante et al., 2023). Finally, understanding that the forensic evidence is placed into this greater institutional framework helps to explain its strength in seeking the truth and the weakness in its implementation in the wrong context or an inadequately regulated environment (Koehler et al., 2023c).

RELIABILITY OF FORENSIC EVIDENCE

Such a decision depends on the applicability of forensic evidence in a trial. Scientific testimony is often seen by courts as objective, impartial and fallacious. However, empirical studies have shown that not every forensic discipline is equally credible and that their evidentiary worth depends not only on scientific validation, but also upon the integrity with which they are used. Reliability is therefore a multifaceted phenomenon comprised of scientific accuracy, procedural protection and institutional believability.

DNA profiling is considered to be the most acceptable forensic evidence. It is based on the principles of population genetics and statistical probability, which allow courts to develop powerful connections between biological material and individuals (Espinoza-Silva et al., 2023). The many examples of wrongful-convictions in the United States that were overturned due to the assistance of DNA testing highlight both the strength of the technology and the dangers of using less accurate methods of forensic analysis (Barton Harrell, 2025). Methods like hair microscopy, bite-mark analysis, and some types of handwriting identification, on the contrary, have been found to have high error rates and have not been empirically validated to produce any valid results, thus creating judicial skepticism about their admissibility (Bonventre, 2021a).

Human factor is one of the main issues of assuring reliability. Forensic science is not exempted of subjective biases, cognitive distortions and institutional pressures. Research shows that forensic examiners might subconsciously explain ambiguous evidence in a manner that prosecutors want them to do, called contextual bias (Lontai et al., 2024). Also, the inconsistency and reliability of forensic results are compromised by the lack of standardized procedures and quality- assurance measures in most jurisdictions.

Laws have tried to solve these issues by formulating admissibility standards. In the US, the Daubert standard demands that expert opinion should be relevant, reliable and scientifically tested, the judges should play the role of the gatekeepers (Singh, 2025). A similar strategy has been embraced by the United Kingdom with the help of the Criminal Procedure Rules that prioritize methodological rigor and the

soundness of expert evidence (Roberts & Zuckerman, 2022). But in Pakistan, courts often accept the forensic evidence without conducting the rigorous investigation of its scientific basis, and this is one of the few gaps in the regulatory and judicial system (Ajmal & Rasool, 2022b). The gap casts suspicions that invalid forensic procedures may be used to cause wrongful convictions, as opposed to preventing them.

Besides, the reliability is subject to the decisive impact of the institutional capacity of forensic laboratories. The mechanisms which are relevant in ensuring that forensic evidence is in accordance with scientific and ethical standards include accreditation, routine audits and peer review. Otherwise, even cutting-edge methods like DNA profiling can be destroyed due to mishandling, contamination, or poor record-keeping (Shepitko & Shepitko, 2021). The bottom line is that although forensic evidence has the potential to increase the accuracy in criminal justice, reliability must never be assumed but constantly tested, examining and reinforced through stringent institutional reforms.

FORENSIC EVIDENCE IN PAKISTAN'S CRIMINAL JUSTICE SYSTEM

In Pakistan, the use of forensic evidence has grown significantly in size over the last twenty years, especially as more specialized institutions have been created as well as a growing dependency by the judiciary on scientific methods of proof. In the past, the criminal justice system in Pakistan was highly reliant on testimonial and circumstantial evidence, which made the process of criminal adjudication too susceptible to manipulation, corruption, and miscarriage of justice. With these shortcomings, the state slowly brought about forensic science as a measure of strengthening accuracy and credibility in criminal proceedings.

Legal and Institutional Framework

The main legislative body that deals with the evidence in Pakistan is the Qānūn-e-Shahadat Order (QSO) 1984 that governs the admissibility and the evidentiary weight of the expert testimony. The QSO under sections 59 and 164 also allow expert opinion on any issue involving handwriting, fingerprints and scientific tests; thus, offering a legal foundation of forensic submissions in court (Mirza & Rizwan, n.d.). Nevertheless, in contrast to countries which use strict admissibility criteria, like the Daubert test in the United States, Pakistan does not have a written framework to evaluate the scientific soundness of expert evidence. This means that the judges have wide discretion when deciding on admissibility which can create inconsistent results.

Punjab Forensic Science Agency (PFSA) is an institution created in 2007 to mark a breakthrough in the forensic infrastructure within Pakistan. PFSA is a multidisciplinary center that provides a range of services, including those related to DNA analysis, toxicology, ballistics and digital forensic research and is considered to be among the most advanced forensic centers in the South Asian region (Zahra & Lohani, 2022). Other provinces are however falling behind in the development of similar facilities and due to this, there is unequal access to the forensic resources nationwide.

Judicial Reception

The courts have become keenly aware of the role of forensic evidence to reinforce criminal proceedings. In Imran Ali v. The DNA profiling (the Zainab murder case) played a leading role in the conviction and proved that the judiciary was ready to use forensic science in case of evidence that is strong and valid (Saddique et al., 2024). However, the courts have warned that forensic reports should not be relied on too much without the support of the corroborating evidence and this is where the balance is needed.

These developments notwithstanding, there are still systemic challenges facing forensic science in Pakistan. The credibility and utility of forensic evidence in litigation is often undermined by delays in delivering forensic reports, lack of qualified staff, and inadequate consciousness of legal professionals

about the use of forensic evidence (Ajmal & Rasool, 2022c). The efficiency of the forensic investigations is further reduced by the backlog of the cases in the forensic laboratories and the lack of resources.

Challenges and Reform Imperatives

The most crucial issue relates to the guarantee of standardization and credibility. The reports of sample mishandling, contamination, and lack of chain-of-custody have questioned the weight of evidence of forensics in Pakistan (Ajmal & Rasool, 2022d). In addition, absence of a national accreditation system of labs compromises both the trust of people and judicial confidence. To a large extent, legal practitioners do not have specially trained scientific evidence, thus limiting their ability to cross-examine expert witnesses in court or challenge untrustworthy forensic reports (Abbas et al., 2024).

Therefore, reform efforts must focus on the development of the forensic infrastructure across the provinces, setting up of an accreditation standard and improvement of the prosecutorial and judicial education in forensic science. The increasing involvement in international organisations and parallel legal systems can provide template tools on the best practices in enhancing the credibility and transparency in the forensic processes in Pakistan (Hussain et al., 2024a).

COMPARATIVE PERSPECTIVES

There are significant differences in the assessment of forensic evidence in the criminal process across jurisdictions, influenced by a range of legal traditions, procedural protection and the extent of scientific incorporation. A comparative study explains why some jurisdictions have developed strict frameworks to evaluate forensic reliability, and others, including Pakistan, are still in an institutional and doctrinal change process.

United States

The U.S. has exercised a strong hand in shaping the rhetoric of forensic evidence, which was mostly achieved by judicially shaped admissibility principles. Expert testimony was first required under the Frye standard (1923), which required that the testimony generally be accepted in the scientific community. This requirement was replaced by the Daubert standard (1993) that requires trial judges to act as a “gatekeeper, thus, making expert evidence reliable and applicable. Peer review, error rates, and scientific acceptance are some of the considerations that are relevant (Gvozdenovic, 2022b). These norms reflect an unwavering commitment to methodological rigor, yet critics argue that the ability of judges to assess complex scientific methodologies is limited (Koehler et al., 2023d). Importantly, the Innocence Project has shown that in the United States, there have been many cases of injustices due to the untrustworthiness of the forensic testification, which has sparked the advocacy to reform the system (Mabry, 2025).

United Kingdom

Unlike this, the United Kingdom relies on statutory and procedural safeguards. Criminal Procedure Rules and the Criminal Practice Directions require expert evidence to be shown to be reliably expert and the expert has a duty to the court and not the parties. The discretion of courts is to keep inadmissible evidence that can be prejudiced or unreliable, and the role of cross-examination is an important task to question the expert opinion (Mabry, 2025). In addition, the collapse of the Forensic Science Service in 2012 shifted the duties to privately managed laboratories, which caused the controversy between the cost, quality control and the right to justice (Morrissey et al., 2023). The approach of UK policies predicts judicial regulation and professional responsibility despite on-going resource limitations.

International Standards and Other Jurisdictions

The world is experiencing an increasing trend in focus on harmonization of forensic standards. European Network of Forensic Science Institutions (ENFSI) has developed the best-practice guidelines and accreditation programs to promote uniformity and dependability between the EU jurisdictions (Nogel et al., 2025a). Similarly, Australia has been able to create the National Institute of Forensic Science that not only promulgates national guidelines but also creates the culture of research in the field of forensic sciences (Bird et al., 2024). These examples highlight the importance of centralized institutions in the process of ensuring standardization and scientific reliability.

Comparative Lessons for Pakistan

Comparing the forensic structure in Pakistan with such jurisdictions, it is evident that the forensic structure is undeveloped. Even though the launch of the Punjab Forensic Science Agency is a positive move, the absence of a written admissibility standard that could be equivalent to the Daubert or ENFSI directions undermines consistency and integrity. Besides, there is still limited judge and lawyer training to assess scientific evidence, and there are still pronounced provincial differences in access to forensic services. Pakistan has to gain advantages on the basis of the comparative experience (i) introducing the accreditation standards in the laboratories, (ii) the codification of rules of admissibility of forensic science, and (iii) the judicial-scientific interaction in order to strengthen reliability.

REFORM NEEDS AND POLICY RECOMMENDATIONS

The successful utilization of forensic evidence in criminal trials is not only dependent on the existence of the scientific method but also on the strength of institutional, legal, and the procedural protections. Notwithstanding dramatic progress in Pakistan, including that of the Punjab Forensic Science Agency (PFSA), there are still inherent deficiencies in the system that undermine reliability and credibility. In order to address these gaps, a comprehensive reform agenda is necessary, incorporating both legal, institutional and educational solutions.

Establishing a Standardized Admissibility Framework

In contrast to the United States, which has a codified system of evaluating the admissibility of forensic science, Pakistan has no codified system of evaluating the admissibility of scientific evidence. Judicial discretion can be an effective tool, but it has uneven results. In turn, the statutory admissibility criteria, reflecting the best practices on the international scale, with a focus on peer review, error rates, and overall acceptance in the scientific community, should be placed at the top of the list of reform priorities (Espinoza-Silva et al., 2023a). Such codification would encourage uniformity and act as a check on untrustworthy expert evidence.

Laboratory Accreditation and Quality Control

The integrity of the labs that are used to generate forensic evidence is closely connected to its credibility. Currently, few forensic labs in Pakistan meet internationally-accepted standards, and inequalities between provinces also make it hard to access them equally. As a result, accreditation to internationally recognized standards - e.g., ISO/IEC 17025 - must be required, and regular audits and control systems (periodically) should be implemented (Roux et al., 2021). Such interventions would enhance reliability not just that, but also make the people and the courts have confidence in forensic evidence.

Training for Judges, Lawyers, and Investigators

In its actual sense, forensic science as a tool is only useful in the hands of the actors of law who are good in their interpretation and application of the scientific principles. The present-day situation in the

Pakistani professional world indicates that most of the judges, prosecutors, and defense counsellors lack proper training in the area of forensic science, and therefore, are unable to critically evaluate any piece of forensic evidence. To counter this deficit, judicial academies and bar councils should introduce dedicated training courses on forensic science so that practitioners can not only have the necessary knowledge to question expert reports and interrogate witnesses but also do so rigorously (Ajmal & Rasool, 2022e).

Investment in Infrastructure and Human Resources

Although the Pakistan Forensic Science Authority (PFSA) has become an admirable model institution, the lack of similar facilities in other provinces has resulted in huge disparities in the accessibility to forensic justice services. The federal and provincial governments should also focus on the creation of multidisciplinary forensic laboratories all over the country, which will provide equal access to forensic services regardless of the jurisdiction. It is also essential to invest in hiring, maintaining, and educating forensic specialists, especially in such new fields as digital forensics and cybercrime which are gaining importance in relation to modern legal investigations (Hussain et al., 2024b).

Strengthening Chain of Custody and Transparency

Trusting forensic evidence depends not only on its accuracy during analysis in the laboratory but also on the integrity of the processes that were applied during the entire process of the evidence to a court. Existing areas of weaknesses in the chain of custody often create the space of tampering and contamination, thus undermining the value of evidence. The introduction of digital tracking capabilities in parallel with the standardization of the evidence management procedure provides a viable channel to reduce these risks significantly (Bonventre, 2021b).

Promoting Research and Collaboration

The culture that supports sustainable forensic system is based on scientific investigation and cooperation between academic institutions, forensic laboratory, and the courts. By mobilizing universities to conduct research, training and development with forensic agencies, innovation can be fostered and can lead to huge contribution to capacity building. In addition, the access of the regional and international networks like European Network of Forensic Science Institutes (ENFSI) would also be beneficial to Pakistan as they would allow sharing the best practices as well as harmonizing standards (Nogel et al., 2025b).

Policy Coherence and Public Awareness

Reform should have a holistic approach not only to technical faults but also to general governance issues. It is necessary to develop strong policy frameworks that would incorporate the forensic science concept of criminal-justice strategy in a coherent way and that would also be supported by campaigns aimed at instilling confidence in the forensic methodologies in the community. An open and responsible forensic system would help reduce the use of forced confessions and traditional ways of investigation, thus, enhancing the rule of law and protecting human rights (Weyermann & Roux, 2021).

Altogether, the forensic system in Pakistan is at the turning point. Though significant gains have been achieved, there are no systemic improvements in the admissibility criteria, institutional framework and training institutions that could make forensic evidence a liability instead of an asset in criminal justice. With the help of comparative models, Pakistan will be able to come up with a consistent approach that will make forensic science the instrument of justice that it promises to be.

CONCLUSION

Forensic evidence has proved itself beyond any doubt as a powerful tool in the arsenal of criminal justice in the present day, with a scientific level of accuracy that when utilized properly could significantly

improve the fairness and accuracy of a court decision. However, as this paper highlights, it does not mean that it is reliable. Although DNA evidence is the gold standard other modalities of forensic evidence, including bite-mark analysis or hair comparison, have failed to satisfy high scientific standards. Human bias, absence of standardization and institutional inefficiencies also contribute to the unreliability of forensic evidence.

In the Pakistani context, the law has formally recognized the evidentiary force of forensic science, but the actual practice is deeply flawed. The inadequate institutional infrastructure, lack of proper training of forensic specialists, lack of quality assurance measures, and an inadequately prepared judiciary unable to value the limitations of science have all contributed to the ineffective application of the forensic evidence. As a result, the courts often assume that forensic testimony is always correct and thus it increases the chances of convicting an innocent individual rather than protecting justice.

A comparison of jurisdictions like the United States and the United Kingdom has shown that successful application of forensic science requires not just high-technology but also a culture of accountability, research and openness. These systems attach importance to the admissibility of evidence basing on scientific validity, intense cross-examination, and control mechanisms. In the case of Pakistan, the introduction of similar reforms is unavoidable to make its criminal-justice procedures correspond to the international best practices.

The above discussion highlights the need to have reform. Legal regulations should enshrine more rigorous admissibility principles; institutional resources should be provided to give forensic laboratories and training a higher priority and courts should be given the power to act as true gatekeepers of scientific evidence. Most importantly, a culture of critical examination, as opposed to uncritical trust in forensic testimony, needs to be promoted so that forensic science can have the effect it should to strengthen justice instead of weakening it.

Finally, forensic evidence can no longer be taken as a self-governing truth. It should be integrated into the Pakistan criminal-justice system on the basis of principles of scientific reliability, procedural fairness, and institutional accountability. It is through wholesale change that Pakistan can be brought to a system of justice where forensic science is no longer a possible source of error, but an actual deterrent.

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