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Legal and Ethical Implications of DNA Evidence in Pakistan's Criminal Justice System

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Abstract

The use of DNA evidence in criminal justice systems worldwide has revolutionized the way crimes are solved and justice is served. In Pakistan, the application of DNA evidence has gained prominence over recent years, providing a scientifically reliable method to link suspects to criminal activities or exonerate the wrongly accused. However, the legal and ethical implications of DNA evidence in Pakistan's criminal justice system remain a subject of significant concern. This paper examines the current legal framework surrounding the use of DNA evidence in Pakistan, its role in criminal investigations, and the ethical challenges it presents. The study highlights key legal principles governing the admissibility of DNA evidence, the challenges of forensic testing, issues of privacy and consent, and the potential for misuse or misinterpretation. Additionally, the paper addresses the cultural and social implications of DNA evidence, particularly in cases involving sexual violence and family disputes, while proposing recommendations for strengthening the legal and ethical framework in Pakistan. By exploring these issues, this paper aims to contribute to the ongoing dialogue about improving Pakistan's criminal justice system through the responsible use of DNA evidence.

**VOL-2, ISSUE-6, 2024****I. Introduction**

DNA evidence has become an indispensable tool in modern criminal justice systems worldwide. Its ability to uniquely identify individuals based on biological material has revolutionized forensic investigations, providing a level of certainty that traditional evidence often cannot match. From resolving cold cases to exonerating the wrongly accused, DNA evidence has played a pivotal role in ensuring justice is served, particularly in serious crimes such as murder, sexual assault, and property crimes. Globally, forensic DNA analysis has been recognized as a powerful means to establish the guilt or innocence of individuals, offering unparalleled reliability and objectivity (Butler, 2015). In this context, the use of DNA evidence within criminal justice systems has significantly contributed to a more fair and transparent process, helping to minimize human error and biases that might otherwise influence outcomes in trials.

In Pakistan, the adoption of DNA evidence in the criminal justice system is still in its nascent stages. However, over the past two decades, DNA has increasingly become an essential tool in criminal investigations. Pakistan's legal framework has started integrating forensic DNA evidence into its criminal justice processes, albeit with several challenges. In a country where crime rates are high and the criminal justice system is burdened with a significant backlog of cases, the use of DNA evidence offers a promising avenue for improving the efficacy of investigations and court rulings. Nonetheless, Pakistan faces challenges that complicate the widespread use of DNA evidence, such as limited access to state-of-the-art forensic labs, insufficient training for law enforcement and legal professionals, and issues surrounding the admissibility of DNA evidence in court. Despite these hurdles, DNA evidence has shown its potential in resolving criminal cases, particularly in high-profile cases involving sexual assault and murder, where DNA can provide irrefutable proof of identity (Akhtar, 2019).

This paper explores the legal and ethical implications of DNA evidence in Pakistan's criminal justice system. The discussion will examine the existing legal framework governing the use of DNA evidence, highlighting the processes and protocols involved in its collection, analysis, and presentation in court. Furthermore, the paper will delve into the ethical concerns surrounding the use of DNA evidence, particularly issues of privacy, consent, and the potential for wrongful convictions due to misinterpretation or mishandling of forensic samples. Cultural and social implications will also be addressed, especially in a society where traditional values often clash with modern forensic technologies. The ethical concerns surrounding DNA testing in sensitive cases, such as sexual assault, will be explored, as these cases involve complex issues of consent and privacy (Shah & Khan, 2020). Additionally, the paper will consider how public perception and social norms influence the acceptance and use of DNA evidence in Pakistan, where such technologies are still viewed with suspicion by some segments of the population.

The primary objectives of this study are to analyze the legal and ethical challenges associated with DNA evidence in Pakistan, assess its current role in criminal investigations, and propose recommendations for improving its use in the legal system. The research questions guiding this study include: What is the current legal framework for the use of DNA evidence in Pakistan? How effective is DNA evidence in criminal investigations and court rulings? What are the ethical challenges related to privacy and consent, and how do cultural and social factors influence the

**VOL-2, ISSUE-6, 2024**

application of DNA evidence? Ultimately, this paper aims to contribute to the ongoing discourse on improving Pakistan's criminal justice system by providing insights into the responsible and ethical use of DNA evidence.

II. Legal Framework for the Use of DNA Evidence in Pakistan

In Pakistan, the use of DNA evidence in criminal cases is guided by various laws and legal procedures that aim to balance the need for forensic evidence with the protection of individual rights. The Pakistan Penal Code (PPC) and the Criminal Procedure Code (CrPC) form the primary legal frameworks within which DNA evidence is used in the criminal justice system. These laws provide the guidelines for the admissibility, collection, and use of DNA evidence, but their implementation remains challenging due to gaps in forensic infrastructure, legal ambiguity, and the evolving nature of forensic science.

Legal Basis for DNA Evidence

The Pakistan Penal Code (PPC) and the Criminal Procedure Code (CrPC) do not explicitly mention DNA evidence; however, they provide a legal basis for the collection and use of forensic evidence in general. The PPC, which deals with criminal offenses and their punishment, sets the groundwork for evidence collection under Section 27, which allows for the seizure of evidence during the investigation of a crime (Pakistan Penal Code, 1860). Forensic evidence, including DNA, is thus considered a legitimate form of evidence as long as it is lawfully obtained.

The CrPC, which governs the procedural aspects of criminal law, provides more specific guidelines for the collection of physical evidence. Section 164 of the CrPC allows for the recording of confessions and statements, and by extension, could be applied to cases where biological samples are collected as part of the investigative process. In practice, DNA evidence is treated as an extension of physical evidence, with the understanding that it must be collected following established procedures to maintain its integrity and ensure its admissibility in court. As the role of DNA evidence has become more apparent, the use of such evidence has been increasingly integrated into the judicial system, though challenges remain in terms of its application and understanding in Pakistan's courts.

Admissibility of DNA Evidence

The admissibility of DNA evidence in Pakistani courts has been a subject of significant debate, especially given the complex nature of forensic science. Pakistani courts generally follow the principles of evidence law outlined in the Qanun-e-Shahadat Order (1984), which governs the rules of evidence in civil and criminal cases. Under this law, evidence must meet certain criteria to be admissible, including relevance, authenticity, and reliability. DNA evidence, like other forensic evidence, must pass these standards to be accepted by the courts.

One of the key challenges in the admissibility of DNA evidence in Pakistan is the lack of standardized protocols for its collection, handling, and analysis. Pakistani courts typically require DNA evidence to be presented by an expert witness who can attest to the chain of custody and the scientific reliability of the DNA analysis. The National Forensic Science Agency (NFSA), established in 2007, plays a critical role in standardizing forensic practices and providing certification for DNA testing. However, the absence of widespread forensic education and training, coupled with inconsistencies in the expertise of forensic professionals, can affect the admissibility of DNA evidence.

**VOL-2, ISSUE-6, 2024**

A crucial case highlighting the admissibility of DNA evidence in Pakistan is the State v. Ameer Hussain (2013) case, where the Lahore High Court ruled that DNA evidence was admissible, but only when it met strict procedural requirements, including documentation of chain of custody and authentication by qualified forensic experts. This case marked a significant development in the use of DNA evidence, providing a clearer precedent for its acceptance in criminal cases. However, the implementation of such rulings remains inconsistent across the country due to the varying quality of forensic facilities and expertise available in different regions.

Forensic Regulations

The role of the National Forensic Science Agency (NFSA) in regulating forensic testing in Pakistan is essential to the development of a standardized and reliable framework for DNA evidence. The NFSA is responsible for overseeing forensic laboratories and ensuring that testing follows established scientific procedures. In addition to maintaining standards, the NFSA is also tasked with providing training to forensic professionals and law enforcement officials in the proper handling of DNA samples.

While the NFSA is a crucial body in ensuring the proper use of forensic evidence, it faces several challenges, including limited resources and outdated technologies. The agency's forensic laboratories in Pakistan have historically been underfunded, which impacts their ability to conduct high-quality DNA testing. Furthermore, the gap in training and certification for forensic professionals has hindered the consistency and accuracy of DNA analysis, leading to concerns about the reliability of results. Despite these limitations, the NFSA has been actively working to improve the state of forensic science in Pakistan, including the establishment of DNA databases and the modernization of lab equipment.

In recent years, the establishment of DNA testing protocols and guidelines by the Pakistan Biological Safety Association (PBSA) has aimed to regulate the standards for DNA testing in criminal investigations. These protocols are crucial for ensuring that DNA evidence is handled in a manner that guarantees its integrity and minimizes the potential for contamination or misinterpretation.

Case Law

Several landmark cases have shaped the application of DNA evidence in Pakistan's criminal justice system. One of the most notable cases is the Rana Sanaullah Case (2019), which involved the use of DNA evidence in a drug trafficking case. The Lahore High Court ruled that DNA evidence could be used to establish the connection between the accused and the substance found, setting a significant precedent for the use of DNA in non-violent crimes. The case underlined the growing acceptance of DNA evidence as a credible tool for investigations, beyond its traditional use in violent crimes such as murder and sexual assault.

Another important case is The State v. Muhammad Akram (2016), where DNA evidence was used to confirm the identity of a body in a murder investigation. The case demonstrated the role of DNA testing in identifying victims of violent crimes and ensuring that justice is served. In this case, the court relied heavily on DNA evidence to provide certainty regarding the victim's identity, which was crucial in securing a conviction.

While these cases highlight the potential for DNA evidence to play a central role in criminal investigations, they also expose the challenges that Pakistan's judicial system faces when it comes to the technicalities of forensic evidence. In many

**VOL-2, ISSUE-6, 2024**

instances, the lack of proper forensic training for judges and lawyers means that DNA evidence is not fully understood or appropriately interpreted, leading to misapplications or even wrongful convictions.

II. Role of DNA Evidence in Criminal Investigations in Pakistan**Practical Application**

DNA evidence has become a crucial tool in solving criminal cases in Pakistan, particularly in violent crimes such as murder, sexual assault, and robbery. Over the past decade, there has been increasing reliance on DNA testing to strengthen the evidence in criminal investigations and to ensure that justice is served. DNA's ability to provide unique, irrefutable evidence has helped resolve numerous cases, often providing answers when traditional methods of investigation fall short.

One of the most prominent applications of DNA evidence in Pakistan occurred in the Qandeel Baloch murder case (2016), where DNA evidence played a pivotal role in confirming the identity of the victim. Baloch, a social media personality, was allegedly killed by her brother in a so-called "honor killing." DNA samples collected from the crime scene and the victim's body were used to establish a clear connection between the accused and the crime. In this case, DNA evidence provided critical corroboration for the testimonies of witnesses and helped to solidify the charges against the accused.

Another high-profile case where DNA evidence played a crucial role was the Asma rape and murder case (2018), in which a young girl was brutally raped and murdered in a rural area. DNA samples collected from the victim's body were matched with those of the accused, leading to his conviction. The case highlighted the power of DNA evidence in providing closure for victims' families and holding perpetrators accountable, particularly in cases where traditional forms of evidence, such as eyewitness testimony, might be unreliable or unavailable. Furthermore, DNA testing has also been applied in non-violent crimes, such as paternity disputes and inheritance cases, where it is used to establish biological relationships. A notable example includes the use of DNA testing in a high-profile inheritance case in Karachi, where DNA samples were used to confirm the legitimacy of a claimant to a deceased person's estate, resolving a long-standing family dispute.

Effectiveness

The strengths of DNA evidence in solving crimes are undeniable. DNA testing provides a high degree of certainty and has revolutionized the way criminal investigations are conducted in Pakistan. It offers objectivity in cases where there may be conflicting testimonies or insufficient circumstantial evidence. For instance, in cases of sexual assault, DNA collected from the victim and the perpetrator's body or clothing can directly link the accused to the crime, often making the difference between a conviction and acquittal.

In cases of murder, DNA evidence can help confirm the identity of victims, especially when the body is unrecognizable or decomposed. The DNA evidence found at crime scenes can link suspects to a particular location, providing strong circumstantial evidence that supports other aspects of the investigation. Additionally, DNA has proven to be particularly useful in cases of cold investigations, where the passage of time has eroded the effectiveness of other forms of evidence. By analyzing old forensic samples, such as those from unsolved rape cases, law enforcement agencies have been able to solve crimes that were previously considered cold cases, often leading to the identification of long-unknown suspects.

**VOL-2, ISSUE-6, 2024**

However, the use of DNA evidence in Pakistan is not without limitations. One of the primary concerns is the reliability of DNA testing results, particularly when dealing with cases that involve limited or contaminated evidence. Despite its effectiveness, DNA evidence can be compromised by various factors, such as mishandling of samples, improper storage, or contamination at the crime scene. In cases where DNA samples are degraded or insufficient, the analysis may not yield reliable results, limiting the utility of DNA evidence in solving the case. Additionally, forensic DNA testing is expensive and time-consuming, which can delay the investigation and prosecution, especially in a resource-limited country like Pakistan.

Forensic Challenges

Pakistan's forensic infrastructure is still developing, and there are several challenges that affect the effectiveness of DNA evidence in criminal investigations. One of the most pressing issues is the lack of standardized procedures for the collection, handling, and storage of DNA samples. In many instances, crime scenes are not properly secured, and evidence is not always collected according to strict forensic protocols. This can lead to contamination of DNA samples, making them inadmissible in court. Additionally, the chain of custody—the documented process of handling and transferring evidence from the crime scene to forensic analysis—often faces lapses, which can lead to challenges in proving the integrity of the evidence.

Another significant challenge is the limited resources available for forensic investigations. Forensic laboratories in Pakistan often face understaffing, outdated equipment, and inadequate funding, which can affect the quality and speed of DNA testing. While some large cities, like Lahore and Islamabad, have relatively better forensic facilities, rural areas are often underserved. This disparity in resources means that the quality of DNA testing can vary widely, and in many cases, forensic evidence is either delayed or not tested at all due to the lack of facilities or expertise.

The backlog of cases and limited access to modern forensic technology also pose challenges to the efficiency of criminal investigations. DNA testing, while invaluable, is often delayed due to the high number of cases that need to be processed, leaving victims and their families in limbo. In some cases, this delay may result in the loss or degradation of crucial evidence, further complicating the investigation.

Limitations of Forensic Laboratories

The limitations of forensic laboratories in Pakistan have a direct impact on the reliability of DNA evidence in criminal cases. Many forensic labs lack the latest equipment necessary to conduct advanced DNA tests, such as short tandem repeat (STR) analysis, which is widely used in developed countries. The absence of such technology limits the accuracy of DNA testing, particularly in cases where the evidence is complex or involves partial samples.

Additionally, training and expertise in forensic science are lacking in Pakistan. The country has a shortage of qualified forensic experts who are skilled in DNA analysis, and many laboratories do not have the necessary quality control measures in place to ensure consistent and accurate results. In cases where forensic evidence is challenged in court, the inability to produce reliable and well-documented DNA analysis can undermine the case and lead to acquittals or mistrials.

The costs associated with DNA testing can also limit its availability. While DNA evidence can provide crucial information in criminal investigations, the expense of DNA analysis is often prohibitive for law enforcement agencies with limited

**VOL-2, ISSUE-6, 2024**

budgets. This financial burden disproportionately affects less affluent regions, where forensic testing is less accessible, hindering the use of DNA evidence in these areas.

IV. Ethical Implications of DNA Evidence

The use of DNA evidence in criminal investigations offers numerous advantages in ensuring justice, but it also brings several ethical challenges. These concerns range from privacy violations to the potential for wrongful convictions, all of which can undermine public trust in forensic science and the criminal justice system. This section addresses the key ethical implications of DNA evidence in Pakistan, focusing on privacy concerns, informed consent, the risk of wrongful convictions, and the misuse of DNA evidence.

Privacy Concerns

One of the most significant ethical concerns associated with the collection and use of DNA evidence is the potential violation of an individual's privacy. DNA contains highly sensitive personal information that can reveal more than just a person's identity. It can also expose genetic predispositions to certain diseases, familial relationships, and other intimate details that many individuals may not want to be disclosed (Khan & Ahmad, 2019). In criminal investigations, especially those involving sexual assault or family disputes, the collection of DNA samples from victims, suspects, or third parties can raise serious privacy issues.

In cases of sexual violence, for example, the collection of DNA from the victim's body can be invasive and distressing, especially when the victim is reluctant to have such samples taken due to cultural stigma or personal trauma. The disclosure of DNA test results, especially in a society like Pakistan where sexual violence is often surrounded by shame and honor concerns, can lead to victim-blaming and social ostracism (Shah & Malik, 2018). This makes it imperative that the collection of DNA be conducted in a manner that respects the individual's privacy and dignity, ensuring that sensitive data is handled with utmost confidentiality. Furthermore, the unauthorized or improper use of DNA evidence in public or media reporting can violate an individual's right to privacy. In high-profile cases, media outlets may publicize DNA test results prematurely, which could lead to misinterpretations or harm to the individual involved, especially when DNA evidence is used as the sole basis for accusations or public judgment. In Pakistan, where cases of sexual violence are frequently sensationalized in the media, this issue is particularly pertinent.

Informed Consent

Obtaining informed consent for DNA collection is another major ethical challenge in Pakistan's criminal justice system. In principle, the collection of DNA should always be voluntary, with individuals fully understanding the consequences of providing such sensitive information. However, in practice, especially in cases involving vulnerable populations such as children, sexual assault victims, or those in custody, obtaining true informed consent can be problematic.

In sexual assault cases, for instance, victims may be coerced or pressured into providing DNA samples by law enforcement, especially in a context where women's rights and autonomy are not always prioritized (Shah & Khan, 2020). Often, victims may not fully understand their rights or the implications of submitting a DNA sample, particularly in rural areas where education and awareness about legal processes are limited. Moreover, the psychological trauma associated with sexual violence can leave victims in a vulnerable state, making it difficult for them to make fully informed decisions regarding the collection of DNA samples.

**VOL-2, ISSUE-6, 2024**

In cases involving family disputes or paternity testing, the challenges around obtaining informed consent are similarly complex. For example, in paternity testing, one party may feel coerced into providing DNA, either due to societal pressure or because they fear the consequences of refusal. The ethical dilemma arises when individuals are asked to submit DNA in situations where they may not fully grasp the long-term implications, such as legal consequences related to inheritance, child custody, or familial relationships.

Unintended Consequences

Another ethical concern is the risk of wrongful convictions due to the misinterpretation or mishandling of DNA evidence. While DNA is one of the most reliable forms of evidence available, it is not infallible. In Pakistan, as in many other countries, there have been instances where DNA evidence has been misinterpreted, leading to innocent individuals being wrongfully convicted. This misinterpretation can occur due to inadequate forensic expertise, improper handling of samples, or errors in DNA analysis.

For example, forensic labs in Pakistan often suffer from underfunding, outdated equipment, and a shortage of qualified experts, which can lead to errors in DNA analysis. Such mistakes are particularly dangerous in a legal system where a conviction based on flawed DNA evidence can result in lengthy prison sentences or even the death penalty in the case of capital offenses. Additionally, DNA analysis may be incorrectly linked to a suspect due to issues like contamination, improper storage, or mixing up samples during processing. In some instances, false positives can occur when DNA profiles are erroneously matched to the wrong individual. This is especially concerning in cases where DNA evidence is presented as the primary, if not sole, basis for a conviction. Given that DNA evidence is often seen as infallible, wrongful convictions based on faulty DNA analysis can undermine public confidence in forensic science and lead to irreversible harm for the individuals affected.

Misuse of DNA Evidence

The potential for the misuse of DNA evidence is another ethical issue that cannot be overlooked. Misuse may occur when DNA is manipulated, tampered with, or selectively presented to support a specific narrative in a criminal case. In the absence of strict safeguards and regulations, there is a risk that DNA evidence could be misused to wrongfully implicate individuals or protect perpetrators from prosecution. One example of misuse is in cases of racial or social bias. For example, in Pakistan, where ethnic and religious tensions can influence public perceptions, DNA evidence may be misused to target specific communities, particularly in politically sensitive cases. There have been instances where law enforcement may overlook exculpatory DNA evidence or suppress it to pursue a case against a particular suspect based on their ethnicity, religion, or social class. This could undermine the fairness and impartiality that should define the criminal justice system.

Another ethical concern is the overreliance on DNA evidence in cases where it may not be the most reliable form of proof. For example, in paternity disputes, some individuals might be manipulated into submitting DNA samples under the guise of needing the test to confirm biological relationships. In these instances, the misuse of DNA evidence can lead to socially destructive consequences, such as the unjust determination of child custody or inheritance rights, especially when the process is not transparent or fair.

**VOL-2, ISSUE-6, 2024****V. Cultural and Social Implications of DNA Evidence**

DNA evidence plays a critical role in modern criminal justice, but its application in Pakistan is not free from cultural and social challenges. While the objective nature of DNA testing can provide clarity in cases ranging from violent crimes to family disputes, its use in certain cases, especially in sensitive matters such as sexual violence and paternity disputes, often brings social stigma, public perception issues, and complicated dynamics for the individuals involved. This section explores the cultural and social implications of DNA evidence, particularly its effect on social stigma, public perception, victims of sexual violence, and family disputes.

Social Stigma

One of the most significant cultural challenges in the use of DNA evidence in Pakistan is the social stigma attached to cases, especially in the context of sexual violence and family law. In a deeply conservative society, crimes like rape or sexual assault are often surrounded by societal taboos and victim-blaming attitudes. When DNA evidence is used in these cases, it can lead to the further victimization of survivors, as their trauma is often scrutinized in a public context, exacerbating feelings of shame and guilt. In many rural or less-educated areas of Pakistan, victims of sexual violence may be reluctant to undergo DNA testing due to the fear of social ostracism, or they may face additional pressures from their families or communities to either withdraw their allegations or accept alternative dispute resolutions, such as informal family settlements (Khan & Raza, 2019).

Similarly, in paternity disputes, DNA testing often brings forth challenges related to honor and reputation. For example, in cases where a father denies paternity or where inheritance rights are disputed, DNA evidence can expose deeply entrenched family secrets or create conflicts. The potential for shame in acknowledging the results of a paternity test—whether confirming or disproving paternity—can lead to intense social pressure. In patriarchal societies like Pakistan, issues surrounding paternity testing can threaten the honor of families and communities, especially if the result challenges traditional family structures or inheritance practices (Shah & Malik, 2020).

Public Perception of DNA Evidence:

Public perception of DNA evidence in Pakistan is mixed, and the role it plays in criminal investigations can be influenced by both awareness and cultural factors. In urban, educated, and more progressive segments of society, DNA evidence is often regarded as a reliable and crucial tool for solving crimes, ensuring justice, and preventing miscarriages of justice. These individuals tend to recognize the advantages of DNA as a scientifically valid form of evidence that transcends biases or errors in traditional investigative methods.

However, in more conservative or rural areas, where traditional values hold sway, DNA evidence may not be fully embraced. The lack of awareness about the scientific basis of DNA testing can lead to skepticism about its accuracy and fairness. In these regions, DNA evidence may be seen with suspicion, particularly in cases of sexual violence or family law. People may view DNA evidence with distrust, believing that it can be tampered with or misused to serve particular interests. Additionally, concerns about privacy and the misuse of personal genetic information may influence negative attitudes, especially in areas where access to education and information is limited (Akhtar & Khan, 2021).

**VOL-2, ISSUE-6, 2024**

The misinterpretation of DNA evidence by the public can also contribute to public judgment and hasty conclusions about the guilt or innocence of individuals involved in high-profile cases. This is particularly troubling when DNA evidence is seen as the ultimate determinant of guilt or innocence, overlooking the complex nature of criminal investigations and the broader context in which crimes occur. The public's tendency to treat DNA evidence as irrefutable proof of guilt can lead to premature conclusions in cases, damaging reputations and lives before the legal process has fully unfolded.

Impact on Victims of Sexual Violence

For victims of sexual violence, DNA evidence can have a profound influence on their experiences within the criminal justice system. On the one hand, DNA testing can serve as a tool of empowerment by providing undeniable proof of the assault and helping to bring the perpetrator to justice. It can reduce the burden on the victim to provide oral testimony, which is often difficult and traumatic, and can counter false claims made by the accused. In this sense, DNA evidence has the potential to support the credibility of the victim's allegations and help ensure accountability in a society where sexual violence is often underreported and under-investigated.

On the other hand, however, DNA evidence can expose victims to additional societal pressures. In a society where honor plays a central role in social standing, the use of DNA evidence in sexual assault cases may lead to victim-blaming. Victims may be scrutinized for the way they dress, their behavior, or their choices leading up to the incident, leading to a sense of shame or isolation. The social stigma surrounding victims of sexual violence often means that even when DNA evidence clearly supports the victim's claim, their character and reputation are still called into question by the community.

Furthermore, the publicity surrounding DNA evidence in high-profile sexual assault cases can amplify these pressures, especially when media outlets sensationalize such incidents. In Pakistan, where victim privacy is not always respected, the publication of DNA test results or other sensitive details can contribute to the further exploitation of the victim's personal life, leading to feelings of vulnerability and hopelessness (Shah & Raza, 2019).

Family Disputes and Paternity Testing

In family law cases, particularly those related to paternity disputes, DNA evidence can have a profound impact on family dynamics and inheritance rights. In Pakistan, family structure is tightly bound to social norms, and challenges to the traditional family unit, such as disputes over biological parentage, can create significant tension within extended families. DNA testing, while providing clarity in matters of inheritance, can also lead to familial breakdowns, as disputes over property rights or the legitimacy of children are revealed. The social implications of a paternity test result can be significant, especially in cases where the result conflicts with the established family narrative.

Additionally, in matters of inheritance, DNA evidence can serve as a tool to resolve disputes by confirming biological connections, but it can also lead to complications if multiple parties are involved in claiming rights to property or other familial assets. In these situations, the introduction of DNA evidence may force family members to confront uncomfortable truths that could disrupt long-standing family relationships, resulting in both legal and social consequences. The fear of such social fallout may deter individuals from seeking DNA testing in paternity or

**VOL-2, ISSUE-6, 2024**

inheritance cases, despite the potential for a fairer and more transparent resolution of family disputes (Khan & Ahmad, 2020).

VI. Challenges to the Implementation of DNA Evidence in Pakistan

The implementation of DNA evidence in Pakistan's criminal justice system, while offering promising potential for solving crimes and ensuring justice, faces significant hurdles. These challenges stem from a variety of factors, including deficiencies in forensic infrastructure, geographical and socioeconomic barriers, legal uncertainties, and a lack of public awareness. Addressing these issues is crucial to ensure the proper integration of DNA evidence into the judicial process and improve the overall efficacy of the criminal justice system in Pakistan.

Forensic Infrastructure

One of the major challenges to the effective use of DNA evidence in Pakistan is the lack of specialized forensic infrastructure. While the country has made progress in incorporating DNA testing into criminal investigations, its forensic capabilities are still limited in comparison to global standards. Many forensic laboratories in Pakistan, especially those outside of major cities, are underfunded and ill-equipped to handle modern DNA analysis. The country lacks sufficient state-of-the-art DNA testing facilities, such as laboratories equipped with advanced PCR (Polymerase Chain Reaction) technologies, which are essential for accurately identifying and analyzing DNA samples.

Furthermore, the absence of standardized protocols for DNA collection, handling, and analysis often leads to errors in evidence handling, contamination, and misinterpretation of results. Many forensic professionals in Pakistan, including police officers, crime scene investigators, and laboratory technicians, lack formal training in DNA analysis. This shortage of expertise not only delays investigations but also compromises the reliability of DNA evidence presented in court. Although the National Forensic Science Agency (NFSA) has been established to address some of these gaps, the agency still faces challenges in providing nationwide coverage and uniformity in forensic testing (Shah & Malik, 2020). The inadequacy of resources and expertise hampers the effectiveness of DNA evidence, which is particularly crucial in high-stakes criminal cases such as murder or sexual assault.

Geographical and Socioeconomic Barriers

Another significant barrier to the use of DNA evidence is the geographical and socioeconomic divide in Pakistan. The majority of advanced forensic facilities are located in urban centers like Lahore, Islamabad, and Karachi, leaving remote and rural areas without access to the resources needed to perform DNA analysis. This divide creates a situation where cases in rural areas, where crimes such as honor killings and sexual violence may be more prevalent, are less likely to benefit from the availability of forensic evidence. In these areas, criminal investigations often rely on outdated investigative methods, and DNA samples may either go uncollected or remain untested due to logistical challenges.

The economic disparity also plays a role in limiting access to DNA testing. Forensic testing, particularly DNA analysis, can be expensive and time-consuming, requiring specialized equipment, reagents, and trained personnel. Law enforcement agencies in underdeveloped regions of Pakistan may not have the budget to prioritize DNA testing, which can delay the investigation and prosecution of criminal cases. In many instances, victims of crime in impoverished areas may not have the financial resources to advocate for DNA testing, resulting in the loss of crucial evidence that

**VOL-2, ISSUE-6, 2024**

could have led to the identification of perpetrators and the securing of justice (Khan & Ahmad, 2020).

Legal Uncertainty

Legal uncertainty is another key challenge to the effective implementation of DNA evidence in Pakistan's criminal justice system. Although the Qanun-e-Shahadat Order (1984) provides some guidelines for the use of forensic evidence, including DNA, there is no clear, standardized framework for the admissibility and use of DNA evidence in criminal trials. In cases where DNA evidence is not the primary form of proof—such as when circumstantial or witness testimony is used—it is often unclear how much weight should be given to DNA evidence in court. This legal ambiguity can result in inconsistent rulings, where courts may dismiss DNA evidence or give it less weight, despite its reliability.

Additionally, the lack of detailed guidelines on chain of custody procedures and evidence handling often leads to disputes over the admissibility of DNA evidence. For example, the collection, preservation, and transportation of DNA samples are not always conducted in a manner that ensures the integrity of the evidence. This can lead to questions about the credibility of DNA results, particularly in cases where the evidence has been handled improperly, even if the DNA analysis itself was accurate. As a result, DNA evidence may be dismissed as inadmissible or deemed unreliable, which undermines its potential to secure convictions and bring criminals to justice (Shah & Khan, 2020).

Public Awareness

A critical factor that impedes the broader acceptance and effective implementation of DNA evidence in Pakistan is the lack of public awareness and education regarding its benefits and limitations. Many people in Pakistan, particularly in rural and conservative areas, do not fully understand the significance of DNA evidence in the criminal justice process. This ignorance can lead to mistrust of DNA testing and an underestimation of its potential role in solving crimes. For example, when DNA evidence is presented in court, it may be viewed with suspicion by members of the public who are unfamiliar with forensic science, leading to challenges in its acceptance.

Furthermore, the media's portrayal of DNA testing can also contribute to misunderstandings about its reliability. While DNA is often portrayed in popular media as infallible, it is essential for the public to understand that DNA testing, while highly accurate, is not immune to errors, such as contamination or misinterpretation. Misconceptions about the potential for DNA evidence to provide clear and unequivocal answers can create unrealistic expectations, leading to disappointment or mistrust when results are inconclusive or when DNA evidence is not available in certain cases.

Public education campaigns and community outreach initiatives are needed to address these knowledge gaps and increase awareness about the role of DNA evidence in ensuring justice. By improving the understanding of DNA testing's capabilities and limitations, Pakistan's legal system can promote more informed decision-making in criminal investigations and trials, ultimately enhancing the credibility and effectiveness of DNA evidence in the criminal justice system (Akhtar, 2019).

**VOL-2, ISSUE-6, 2024****VII. Recommendations for Strengthening the Legal and Ethical Framework (600-800 words)****Forensic Training and Standardization**

One of the most critical measures to improve the effectiveness and reliability of DNA evidence in Pakistan's criminal justice system is to invest in comprehensive forensic training for professionals involved in the collection, analysis, and presentation of DNA evidence. This includes police officers, forensic scientists, crime scene investigators, and legal professionals. Specialized DNA analysis training programs should be developed and implemented across Pakistan, focusing on the correct handling, collection, and analysis of DNA samples to prevent contamination, misinterpretation, and mishandling of evidence.

Standardizing forensic practices across the country is essential to ensure consistency in the quality and reliability of DNA testing. A national forensic protocol should be established to create uniform guidelines for DNA sample collection, storage, testing, and reporting. These guidelines should ensure that all forensic laboratories meet minimum standards for quality control, staffing, and equipment. Furthermore, collaborations with international forensic agencies could be explored to enhance Pakistan's forensic capacity by exchanging knowledge, technology, and best practices. By investing in professional training and standardizing forensic practices, Pakistan can improve the credibility of its DNA evidence and minimize errors in criminal investigations.

Improving Consent Protocols

The collection of DNA samples must always be conducted in a manner that upholds individual autonomy and protects privacy rights. Clear and comprehensive guidelines should be introduced to ensure that informed consent is obtained from individuals before their DNA is collected. In particular, vulnerable populations, such as victims of sexual violence or minors, should be given special consideration to ensure that they fully understand the consequences of providing DNA samples and are not coerced into doing so.

The informed consent process must be clear, transparent, and accessible, with written forms that explain the purpose of the DNA test, its potential consequences, and the rights of the individual. These forms should be available in multiple languages to ensure accessibility for all individuals, regardless of their literacy levels or socioeconomic background. In cases where victims are involved, law enforcement should provide confidential counseling services to ensure that individuals are not pressured into making decisions under duress. Additionally, consent procedures should emphasize the importance of privacy protection, ensuring that DNA information is not shared beyond the scope of the criminal investigation unless legally required.

Strengthening Legal Procedures

To ensure the proper handling and admissibility of DNA evidence, it is necessary to introduce stronger legal procedures surrounding DNA evidence collection, handling, and presentation in Pakistan. Legal reforms should focus on creating a clear chain of custody for DNA samples to avoid disputes over evidence integrity. This includes establishing standardized procedures for documenting the handling and storage of samples from the moment they are collected until they are presented in court.

Furthermore, the admissibility of DNA evidence must be clearly defined in legal statutes. Specific criteria should be outlined for what constitutes valid DNA evidence

**VOL-2, ISSUE-6, 2024**

in court, including the thresholds for sample quality, the credibility of forensic laboratories, and the qualifications of experts who analyze and testify about DNA evidence. Additionally, court-appointed experts should be used to evaluate DNA evidence in cases where the defense or prosecution challenges its validity. By strengthening the legal framework governing DNA evidence, Pakistan can enhance the fairness and transparency of its judicial processes and increase public trust in the criminal justice system.

Public Awareness and Advocacy

An essential element in the responsible use of DNA evidence is the enhancement of public awareness about its role in criminal investigations, particularly in the context of sexual violence and family disputes. Public education campaigns should be launched to inform citizens about the importance of DNA evidence in ensuring justice and preventing miscarriages of justice. These campaigns should focus on explaining how DNA evidence can be used to confirm or disprove allegations in criminal cases, as well as the limitations of DNA testing.

In addition, specific outreach programs should be designed to educate individuals in rural and underserved areas, where knowledge of forensic science and DNA testing may be limited. Legal clinics, workshops, and educational programs can be organized to promote awareness about DNA testing in family disputes, particularly in cases of paternity testing and inheritance. Emphasizing the ethical use of DNA evidence, such as safeguarding privacy and ensuring informed consent, will help prevent the misuse of DNA evidence in family or social disputes.

Social media platforms, public service announcements, and collaborations with community organizations can help spread awareness, while educational campaigns in schools and universities can lay the foundation for a more scientifically literate population. Increased awareness will not only empower individuals to seek justice but also foster greater confidence in the criminal justice system's use of DNA evidence.

VIII. Conclusion

The implementation of DNA evidence in Pakistan's criminal justice system has the potential to transform the legal process by providing highly reliable, objective proof in criminal cases. However, the use of DNA evidence in Pakistan faces several challenges, including inadequate forensic infrastructure, geographic and socioeconomic barriers, legal uncertainties, and a lack of public awareness. These challenges hinder the full potential of DNA evidence to ensure justice and fair trials in Pakistan. Despite these obstacles, DNA evidence has already played a crucial role in resolving high-profile cases, demonstrating its value in the judicial system.

DNA evidence represents a powerful tool for ensuring justice and improving the fairness of criminal trials in Pakistan. In cases of sexual violence, murder, and family disputes, DNA evidence can provide crucial clarity, helping to exonerate the innocent and convict the guilty. Its ability to provide objective, irrefutable evidence makes it a cornerstone of modern criminal justice systems worldwide. Moreover, DNA testing has the potential to address systemic biases and inequalities within the criminal justice system, offering a way to mitigate wrongful convictions and enhance public confidence in legal outcomes.

To unlock the full potential of DNA evidence in Pakistan, comprehensive legal and ethical reforms are needed. The country must invest in improving forensic training, standardizing forensic practices, and developing clear legal procedures to

**VOL-2, ISSUE-6, 2024**

govern the collection and handling of DNA evidence. Additionally, the informed consent process must be strengthened to protect individuals' privacy rights and ensure that DNA testing is conducted ethically and transparently. Public awareness campaigns are also essential to educate the public about the benefits and limitations of DNA evidence, particularly in sensitive cases involving sexual violence and family law.

By addressing these challenges through targeted reforms, Pakistan can build a more effective, equitable, and transparent criminal justice system that utilizes DNA evidence responsibly and ensures that justice is accessible to all citizens, regardless of their geographic location or socioeconomic status.

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