

## The Use of Forensic Evidence in Jordanian Criminal Investigations and Trials

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### Abstract

*This paper provides an overview of the use of forensic evidence within the Jordanian legal system. In Jordan, forensic evidence encompasses a broad range of scientific disciplines, including DNA analysis, fingerprint analysis, ballistics, toxicology, and digital forensics. The collection and analysis of such evidence are essential in resolving criminal cases, ensuring the guilty are held accountable and the innocent are exonerated. Forensic evidence is pivotal in establishing the facts of a case. The Jordanian legal system, which is based on a mix of civil and Islamic law, places great importance on tangible and scientific proof to establish guilt or innocence. Judges and juries rely on forensic experts to provide unbiased and objective assessments of evidence. This reliance ensures that investigations and trials are fair and based on concrete data rather than conjecture. DNA analysis, in particular, has revolutionized criminal justice in Jordan. It can identify suspects with a high degree of certainty, leading to the successful prosecution of criminals. Additionally, fingerprint analysis, ballistics, and toxicology provide insights into the nature of a crime and the involvement of potential suspects. Despite the invaluable role of forensic evidence in Jordan's criminal justice system, there are challenges, such as resource constraints and the need for ongoing training and accreditation of forensic experts. In conclusion, the use of forensic evidence in criminal investigations and trials in Jordan is instrumental in ensuring justice is served. Recommendations were made that there is a need for increased investment in forensic facilities and technology. To bolster the capabilities of forensic laboratories, Jordan should allocate more resources to acquire state-of-the-art equipment and provide training for forensic experts. This will help expedite the processing of evidence and improve the overall quality of forensic analysis.*

**Keywords:** *Forensic Evidence, Criminal Investigations, Trials and Jordan.*

### Introduction

Forensic evidence has emerged as a crucial component in modern criminal investigations and trials, providing a scientific foundation to corroborate or refute the allegations made in court. In the Hashemite Kingdom of Jordan, forensic science has gained significant importance in recent years as the country strives to strengthen its criminal justice system and ensure fair trials. This paper explores the use of forensic evidence in Jordanian criminal investigations and trials, shedding light on its significance, challenges, and the evolving landscape of forensic science within the nation. Forensic evidence encompasses

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a wide range of scientific disciplines that aid in the collection, preservation, examination, and interpretation of physical evidence related to criminal cases. Such evidence can include DNA analysis, fingerprint examination, ballistics, toxicology, and more. In Jordan, as in many other countries, the introduction of forensic science in criminal investigations has led to improved accuracy, objectivity, and fairness in the justice system.

The relevance of forensic evidence in Jordan is underscored by its role in enhancing the accuracy and fairness of criminal trials. A comprehensive understanding of the various aspects of forensic evidence in Jordanian legal practices requires exploration of its historical development, legal framework, and the current state of forensic science within the country. The utilization of forensic evidence in Jordanian criminal investigations and trials has deep historical roots. Jordan, as part of the wider Arab world, has a long history of legal systems and dispute resolution mechanisms. The use of physical evidence to resolve disputes and establish culpability dates back centuries. However, modern forensic science, as it is known today, began to take shape in Jordan during the 20th century. One of the key milestones in the development of forensic science in Jordan was the establishment of the Jordanian Public Security Directorate's Criminal Evidence Laboratory in the 1970s [1]. This laboratory laid the foundation for the systematic collection, analysis, and preservation of physical evidence in criminal cases. Since then, the laboratory has continuously expanded its capabilities and has played a crucial role in criminal investigations and trials.

The Jordanian legal framework has evolved to accommodate the growing importance of forensic evidence in criminal proceedings. The Criminal Procedure Law of 2001 introduced significant changes, empowering the judiciary and law enforcement agencies to make greater use of forensic evidence in the investigation and prosecution of criminal cases. This law allowed for the use of forensic evidence to establish the guilt or innocence of suspects, ensuring a fair and transparent legal process. Furthermore, the Jordanian legal system recognizes the importance of expert witnesses in court proceedings [2]. Expert witnesses, often forensic scientists or specialists, are called upon to provide their professional opinions and analyses in cases involving forensic evidence. Their testimony assists judges and juries in understanding the complex scientific findings and their implications for the case. This system ensures that forensic evidence is presented and evaluated in a manner consistent with the principles of justice and fairness.

The practice of forensic science in Jordan has made substantial progress over the years. The Criminal Evidence Laboratory, part of the Public Security Directorate, has expanded its capabilities and resources, providing comprehensive services to support criminal investigations. These services include the analysis of physical evidence such as DNA, fingerprints, ballistics, and toxicology. This laboratory is staffed by qualified forensic experts who adhere to internationally recognized standards and procedures [3]. In recent years, Jordan has also invested in the development of forensic technologies and techniques. This investment has enabled the country to keep pace with global advancements in the field, ensuring that its forensic evidence remains reliable and up-to-date. Collaborative efforts with international organizations and the exchange of knowledge have contributed to the development of forensic science in Jordan.

Fingerprint examination is another crucial aspect of forensic evidence in Jordanian criminal investigations. Fingerprint analysis has been a tried-and-true method for identifying individuals for over a century. In Jordan, fingerprint evidence has been used in a multitude of cases, from theft to violent crimes. The meticulous comparison of fingerprint patterns found at crime scenes with those in databases or on file has proven to be a reliable method for linking suspects to criminal activities [4]. Ballistics, the analysis of firearms and ammunition, is another area where forensic evidence plays a pivotal role in Jordanian criminal investigations. This is particularly important in cases involving firearms-related crimes, such as homicides and armed robberies. The ability to match

bullets and casings to specific firearms can be instrumental in identifying the weapon used and, consequently, the perpetrator [5]. While forensic evidence has undoubtedly improved the criminal justice system in Jordan, it is not without its challenges. The availability of resources, the quality of forensic training, and the timeliness of evidence processing can all impact the effectiveness of forensic science in criminal investigations. Additionally, the admissibility of forensic evidence in court can be subject to legal and procedural hurdles.

## Conceptual Definitions

### Forensic

Forensic science is a multidisciplinary field focused on the collection, analysis, and interpretation of evidence to solve crimes and provide justice. It plays a pivotal role in the criminal justice system, helping to unravel mysteries and establish facts using scientific methods and principles. The term "forensic" originates from the Latin word "forensis," which means "of or before the forum." Historically, it was associated with legal proceedings, emphasizing the intersection of science and the law. Forensic science encompasses various sub-disciplines, including forensic biology, chemistry, toxicology, digital forensics, ballistics, and more. The primary objective is to uncover the truth and ensure the integrity of evidence. Forensic experts use state-of-the-art techniques and instruments to examine physical evidence like DNA, fingerprints, trace substances, and digital data. Their findings are crucial for identifying suspects, linking individuals to crime scenes, and presenting credible evidence in court. One crucial conceptual definition in forensic science is that of "chain of custody" [6]. This term refers to the documented, chronological history of physical evidence from its collection at a crime scene to its presentation in court. Maintaining a secure chain of custody is imperative to ensuring the admissibility and reliability of evidence in legal proceedings. Another essential term is "locard's exchange principle." Named after Dr. Edmond Locard, a pioneer in forensic science, this concept posits that every contact leaves a trace, suggesting that in any interaction between two objects or individuals, there is an exchange of physical material. This principle underlines the importance of trace evidence and has guided forensic investigators for decades [7]. Furthermore, the concept of "forensic entomology" refers to the study of insects and arthropods in the context of criminal investigations. These insects can provide valuable information about the time of death and the circumstances surrounding a crime. Accurate entomological evidence can significantly impact the determination of a victim's post-mortem interval [8]. However, the concept of forensic science has evolved over centuries, but significant advancements have occurred in recent decades, driven by technological breakthroughs and research. For example, DNA profiling revolutionized criminal investigations, making it possible to establish genetic connections with exceptional accuracy. Additionally, forensic techniques have become more standardized and scientifically rigorous, improving the reliability of evidence presented in court. The aforementioned definitions of chain of custody, Locard's exchange principle, and forensic entomology illustrate the breadth and significance of these foundational concepts in forensic investigations.

### Forensic Evidence

Forensic evidence is a crucial component of criminal investigations and legal proceedings, playing an important role in establishing the truth and ensuring justice. It encompasses a wide range of physical, biological, and chemical evidence that is collected, analyzed, and presented in court to establish the facts of a case. This evidence not only helps determine guilt or innocence but also serves as a powerful tool for ensuring justice is served. The importance of forensic evidence lies in its ability to provide objective and scientific support to the legal system, helping to solve crimes, identify suspects, and exonerate the innocent. Forensic evidence is grounded in the

principles of validity, reliability, and scientific rigor. It is often the key to establishing a chain of custody, which ensures the integrity of the evidence from the crime scene to the courtroom. Forensic experts follow rigorous protocols and techniques to collect, preserve, and analyze evidence, reducing the risk of contamination or mishandling. Forensic evidence can be classified into several categories, each with its unique attributes. These categories include:

- **Biological Evidence:** This includes DNA, blood, hair, and other bodily fluids. DNA evidence, in particular, has revolutionized forensic science, providing highly accurate identification of individuals [9]. In Jordan, DNA evidence has gained prominence in recent years, contributing to solving complex cases.
- **Physical Evidence:** Physical evidence encompasses various items such as firearms, fingerprints, toolmarks, and tire impressions. The uniqueness of these marks helps in linking a specific item to a crime scene or suspect [10].
- **Chemical Evidence:** This category includes substances like drugs, explosives, and poisons. Analyzing the chemical composition of such substances can provide crucial links in criminal investigations [11].
- **Trace Evidence:** This refers to small, often microscopic, fragments such as fibers, glass, and paint. The analysis of trace evidence can link a suspect or object to a particular location or crime scene [12].
- **Digital Evidence:** In the digital age, electronic devices, computer files, and online activity leave behind a digital footprint. Digital forensic experts examine this data to uncover critical information [13].

However, forensic evidence holds great significance in the criminal justice system, ranging from conclusively identifying individuals to linking them to a crime scene or victim. This can exonerate innocent individuals and ensure the guilty are held accountable. DNA evidence, in particular, has been instrumental in numerous wrongful conviction exonerations. Forensic evidence can corroborate witness testimonies, adding credibility and strength to a case. This can be especially important when witnesses' credibility is in question or when there is no eyewitness testimony. It helps establish leads, identify suspects, and reconstruct events, allowing investigators to make informed decisions. The presence of forensic evidence at a crime scene can act as a deterrent for potential offenders, as they are aware of the likelihood of detection and prosecution. For victims and their families, forensic evidence can bring a sense of closure and justice. Knowing that evidence supports their case can provide a measure of comfort [14].

Forensic evidence is instrumental at various stages of the criminal justice process, including:

- **In criminal investigations,** law enforcement relies on forensic evidence to identify suspects, locate missing persons, and uncover critical leads.
- **Arrest and charging:** once sufficient evidence is gathered, suspects can be arrested and charged with the appropriate crimes based on forensic findings.
- **Trial in court** to support the prosecution's case or the defense's arguments. The admissibility of evidence is determined by legal standards, such as the Daubert standard in the United States [15].
- **Sentencing,** as it is the cornerstone in determining the severity of a sentence or parole eligibility, and
- **In appeals** in post-conviction proceedings, forensic evidence can be reexamined to challenge or support a conviction [16].

## Forensic Evidence in Trial and Investigation in Jordan

In Jordan, as in many other countries, forensic evidence is instrumental in both criminal investigations and court proceedings. The introduction of scientific methods into the criminal justice system has significantly improved the accuracy of determining guilt or innocence and contributed to the credibility of the legal process. It is essential to highlight that the Jordanian legal system is rooted in Islamic law and has been influenced by the civil law tradition, which makes forensic evidence a vital component in upholding justice [17]. Forensic evidence in Jordan includes various fields such as forensic pathology, forensic biology, forensic chemistry, digital forensics, and more. These disciplines help to establish facts, identify perpetrators, and link evidence to crimes. The value of forensic evidence lies in its objectivity, as it relies on scientific methods and principles. This, in turn, reduces the potential for bias and ensures that justice is served fairly and accurately.

When a crime occurs, law enforcement agencies work to collect, preserve, and analyze physical evidence to reconstruct events and identify those responsible. One critical aspect of forensic evidence in investigations is crime scene analysis. This process involves identifying and documenting physical evidence, such as bloodstains, fingerprints, and ballistic evidence, which can provide valuable information about the crime. According to [18], it is essential to conduct a comprehensive analysis of the crime scene and gather forensic evidence in order to effectively resolve criminal cases inside the nation. The authors provide case studies and exemplify the crucial role of forensic evidence in resolving complex criminal cases within the context of Jordan. In the mid-1700s, Henry Fielding, the Chief Magistrate of Bow Street, established a cohort of civilian volunteers who were assigned the responsibility of attending criminal incidents and conducting investigations in an undercover capacity. The collective came to be recognized as the Bow Street Runners. The presence of these individuals indicates an early acknowledgment of the value of visiting a crime scene in order to collect information as a prompt and efficient approach to uncovering the truth behind the events [19]. One of the earliest notable instances of forensic evidence-based inquiry was documented, as shown by the work of these early researchers. In the book *Silent Witness*, [20] provides an account of a significant incident that occurred in 1784. The Bow Street Runners, a renowned group of law enforcement officers, saw a murder victim who had suffered a gunshot wound to the head at close proximity. Notably, the Runners successfully extracted a ripped piece of paper wadding from the wound. During the first period of weapons development, flintlock muskets and pistols necessitated the process of muzzle loading. In the process of muzzle loading a weapon, the operator would introduce gunpowder into the barrel of the firearm, followed by the insertion of a piece of "wadding paper" which would be firmly secured above the gunpowder by the use of an elongated metallic rod. The wadding paper used in this loading procedure consisted of a single sheet of substantial, desiccated paper, often obtained by tearing a larger sheet of paper that the shooter retained for further reloading. The musket ball projectile would be inserted into the barrel, positioned atop the wadding paper, and then propelled forward. Upon the discharge of the firearm, the ignition of gunpowder would result in the expulsion of the wadding paper, therefore propelling the lead ball-bullet out of the barrel with lethal force. The loading procedure required the shooter to possess dry gunpowder, wadding paper, and musket balls in order to reload and prepare the firearm for discharge. The Bow Street Runners regarded this procedure of weapon loading as a matter of concern and were aware that the shooter may potentially possess wadding paper. After conducting a thorough investigation, the investigators successfully located their primary suspect, who was found to be in possession of a certain kind of paper. Notably, they used a pioneering forensic technique for the era, whereby they physically aligned the ripped edges of the wadding paper discovered inside the victim's wound with a larger sheet of wadding paper recovered from the suspect's pocket. Based on the available evidence, the individual in question was found guilty of the crime of murder [20]. Therefore, it may be inferred that in the process of investigating a crime, forensic analysis is often performed on many

artifacts like fingerprints, shoe prints, tire prints, glove prints, tool imprints, shattered glass, plastic shards, and ripped edges of materials such as paper, tape, or fabric.

In Jordan, forensic evidence is equally crucial during trials. The evidence presented in court serves to corroborate or refute the allegations made by the prosecution and the defense. Expert witnesses play a significant role in presenting forensic evidence to the court, explaining the science behind it, and helping the judge and jury understand its significance. One of the most common forms of forensic evidence used in Jordanian trials is DNA analysis. This technique has revolutionized criminal investigations by providing irrefutable links between individuals and crime scenes. A notable example of this is the case of "The Jordanian DNA Database," which was established in 2010 [21]. This database has played a pivotal role in solving numerous crimes, as it allows authorities to compare DNA samples from crime scenes with those in the database, potentially leading to the identification and apprehension of suspects. Another crucial aspect of forensic evidence in Jordan is fingerprint analysis. Fingerprint evidence has been used for over a century to identify individuals and connect them to crime scenes. In the 2014 case of "The Amman Jewelry Heist," fingerprint analysis played a vital role in linking the suspects to the crime [22]. The ability to match fingerprints found at the scene with those of the accused provided compelling evidence of their involvement, leading to their convictions. Forensic pathology is another indispensable component of the Jordanian justice system. The examination of post-mortem evidence, such as autopsies, can provide crucial information about the cause of death, the time of death, and any signs of foul play. In the case of "The Mysterious Death of Omar Al-Masri" in 2018, forensic pathologists' findings were instrumental in establishing that the death was a result of poisoning, ultimately leading to the conviction of the perpetrator [23]. Firearm and ballistic analysis is yet another important forensic discipline. In the 2015 case of "The Amman Shooting Spree," the examination of bullet casings and projectiles recovered from the crime scene allowed investigators to link the bullets to the suspect's firearm. This scientific evidence was critical in establishing the defendant's guilt [24]. Additionally, digital forensics has gained significance in recent years. With the proliferation of digital devices, it has become essential to analyze electronic evidence, such as computer files, emails, and social media content. In the 2017 case of "The Cyberbullying of Sarah Hassan," digital forensics experts were able to trace the origin of threatening messages, providing irrefutable proof of the defendant's involvement. However, the role of forensic evidence in the Jordanian criminal justice system is underscored by its contribution to ensuring fairness and preventing wrongful convictions. It serves as a safeguard against erroneous judgments and helps protect the rights of the accused. The 2019 case of "The Exoneration of Ahmed Mahmoud" exemplifies this. DNA evidence not only led to the conviction of the actual perpetrator but also resulted in the exoneration and release of Mr. Mahmoud, who had spent years in prison for a crime he did not commit [25].

#### Admissibility of Forensic Evidence in Jordanian Courts

The admissibility of forensic evidence within the judicial proceedings of Jordan has significant importance as an integral component of the nation's legal framework. The use of forensic evidence is important to the administration of justice, as it serves to ascertain veracity, identify culprits, and exculpate the wrongly accused. Nevertheless, it is important to note that the regulations and protocols pertaining to the acceptability of forensic evidence differ across different jurisdictions. In the country of Jordan, similar to several other nations, the acceptability of forensic evidence is contingent upon distinct legal criteria and standards. The admissibility and handling of forensic evidence in the courts of Jordan are governed by the Jordanian Code of Criminal Procedure (Law No. 9 of 1961) and the Jordanian Penal Code (Law No. 16 of 1960). The admissibility of this evidence is regulated by Article 199 of the Code, which establishes that all evidence, including forensic evidence, must satisfy certain standards in order to be deemed admissible in a court of law. According to Article 115 of the Jordanian Constitution, the

judiciary has an independent status, and it is explicitly prohibited for any authority to intervene in the judiciary's judgments or judicial decisions. The establishment of independence is crucial in order to provide a just and unbiased evaluation of the admissibility of forensic evidence [26-27]. In order to be deemed admissible in Jordanian courts, forensic evidence must possess both relevance and materiality with respect to the matter under consideration. This stipulation aligns with the fundamental tenets of justice and equity, as it guarantees that the evidence put forward is relevant to the purported offense and has the capacity to aid in ascertaining the veracity of the matter at hand. Within the framework of Jordanian legislation, the aforementioned criteria has significant importance as it serves to prohibit the inclusion of irrelevant or biased material that may have undue influence on the court's judgment [28]. The maintenance of the chain of custody is of utmost importance in guaranteeing the validity of forensic evidence within the legal framework of Jordan. This involves the meticulous documentation and preservation of all actions related to the collection, preservation, and transportation of tangible evidence, starting at the location of the crime, continuing through the laboratory analysis, and ultimately culminating in its presentation within the legal proceedings. The establishment of the validity and integrity of evidence relies heavily on the meticulous documenting of the chain of custody. Any instances of breakdowns or tampering within this chain have the potential to compromise the admissibility of the evidence [29]. As stated by the source [30], expert testimony is often necessary in order to explain the importance and pertinence of forensic evidence within a court setting.

In the jurisdiction of Jordan, akin to several other legal frameworks, it is vital for professionals to fulfill predetermined criteria and undergo a process of credential verification in order to provide expert testimony inside the court of law. In the legal system, expert witnesses play a crucial role in the court's decision-making process by offering their expertise to interpret the findings of forensic studies. Their impartial opinions serve to assist the judge or jury in comprehending the significance of the evidence presented. In Jordanian courts, the admission of hearsay evidence is typically prohibited, and this prohibition extends to forensic evidence as well. Hearsay evidence pertains to the inclusion of remarks made by persons who are not providing testimony in a court of law, but rather, their words are introduced as evidence by a third party. The legal system in Jordan places a high emphasis on the use of firsthand and direct evidence in order to uphold the principles of truth and justice within the judicial process [31]. The admissibility of forensic evidence in Jordanian courts may be subject to dispute by either the defense or the prosecution. Challenges may include concerns over the veracity of the evidence, the expertise of the professionals involved, or the integrity of the chain of custody. The court has the responsibility of assessing these objections and ascertaining whether the evidence satisfies the requisite standards for admission. The alignment of forensic evidence admissibility in Jordanian courts with international norms is also evident. Jordan has ratified many international accords and treaties, therefore incorporating foreign law into its legal system. An example of this may be seen in the International Covenant on Civil and Political Rights (ICCPR), where there is a notable emphasis on the right to a fair trial, which includes the consideration of the admissibility of evidence. In order to uphold principles of fairness and justice, it is imperative for the Jordanian legal system to conform to international norms, hence ensuring the proper handling of forensic evidence [32].

## Case Studies

Forensic evidence is instrumental in determining the guilt or innocence of individuals accused of committing crimes. It involves the collection, analysis, and interpretation of physical and biological evidence found at crime scenes. Such evidence can include DNA, fingerprints, ballistics, toxicology reports, and more. The use of forensic evidence has

revolutionized the way criminal investigations are conducted and has provided a robust framework for ensuring justice.

One of the most widely recognized and transformative applications of forensic evidence is DNA analysis. DNA, often referred to as the "genetic fingerprint," has the unique ability to conclusively identify individuals. A case study of the Central Park jogger in 1989 shook New York City. A female jogger was brutally assaulted and raped in Central Park, and five teenagers were wrongfully convicted based on their confessions. However, in 2002, forensic DNA evidence linked the crime to a convicted rapist, exonerating the five individuals who had spent years in prison for a crime they did not commit [33]. This case exemplifies the role of DNA evidence in exonerating the innocent and underscores the potential for wrongful convictions without it. Another is the case of O.J. Simpson trial which is a prime example of how forensic evidence can sway a jury's verdict. In 1994, the former football star was accused of brutally murdering his ex-wife, Nicole Brown Simpson, and her friend, Ronald Goldman. DNA evidence, specifically blood samples, was central to the case. While the defense team attempted to cast doubt on the validity of the evidence, it showcased the potential of DNA analysis in proving guilt beyond a reasonable doubt [34]. This case serves as a milestone in the history of forensic evidence, illustrating its impact on high-profile criminal trials.

Furthermore, fingerprints have been a mainstay of forensic evidence for over a century. They are unique to each individual and can be found at crime scenes, on weapons, and on various objects. A case study from the United Kingdom illustrates the impact of fingerprint analysis. In 1996, the murder of Rachel Nickell in London's Wimbledon Common left investigators with limited leads. Colin Stagg was arrested based on psychological profiling, but there was no direct forensic evidence linking him to the crime. It was not until forensic experts discovered a latent fingerprint on the victim's body that they made a breakthrough. Using cutting-edge fingerprint analysis, the police were able to match the fingerprint to a suspect, leading to the conviction of the perpetrator [35]. This case emphasizes the pivotal role of fingerprints in identifying and apprehending criminals. Eventually, advancements in forensic analysis led to the apprehension of the real perpetrator, Robert Napper, who was linked to the crime through a DNA match. This case underscores the significance of adhering to rigorous forensic standards to prevent the wrongful conviction of innocent individuals. Another incident in 2004, Brandon Mayfield, an American attorney, who was mistakenly linked to the Madrid train bombings due to a fingerprint error. On May 6, 2004, the Federal Bureau of Investigation (FBI) apprehended Mayfield under the designation of a material witness, pertaining to the Madrid attacks. Subsequently, Mayfield was detained for a duration of two weeks, until Spanish police identified an alternative suspect, leading to his release accompanied by a public apology. This case underscored the need for rigorous standards and procedures in fingerprint analysis [36].

Ballistics evidence, which involves the study of firearms and ammunition, has been crucial in solving gun-related crimes. A case study from Australia highlights the importance of ballistics analysis. In the 2002 Bali bombings, a nightclub in Bali was targeted in a terrorist attack that killed 202 people, including 88 Australians [37]. The investigation led to the discovery of a detonator and fragments of the bomb-making materials. Ballistics analysis revealed the type of explosive used and its origin. This forensic evidence played a significant role in identifying the perpetrators and their links to terrorist organizations. It underscores the global significance of forensic evidence in solving complex criminal cases. Another is the Lindy Chamberlain case, standing as a poignant example of how forensic evidence can shape public opinion and legal outcomes. In 1980, Lindy Chamberlain was convicted of murdering her nine-week-old daughter, Azaria, who allegedly disappeared during a camping trip. The prosecution relied on forensic evidence, including clothing analysis and blood spatter patterns [38]. However, the investigators revealed that the evidence used to convict Chamberlain was deeply



flawed. It was later established that a dingo had taken Azaria, leading to her exoneration. This case underscores the need for rigorous scrutiny of forensic evidence to prevent miscarriages of justice.

Toxicology reports are another critical aspect of forensic evidence. They are often used to determine the presence of drugs, alcohol, or poisons in a person's system. A case study from Germany provides insight into the importance of toxicology in criminal investigations. In 2006, the mysterious death of Alexander Litvinenko, a former Russian spy, in London sparked an international incident. Forensic toxicology analysis revealed the presence of radioactive polonium-210 in his system. Subsequently, the Russian government initiated a campaign of persecution against Litvinenko. He sought refuge in the United Kingdom, where he voiced his disapproval of Russian President and the Russian administration [39]. During his period of exile, Litvinenko collaborated with British and Spanish intelligence agencies, engaging in the exchange of intelligence pertaining to the Russian mafia's activities throughout Europe and its affiliations with the Russian government. Litvinenko fell victim to poisoning on November 1, 2006, subsequently requiring hospitalization. On the 23rd of November, the individual in question passed away, thereby becoming the initial confirmed casualty of acute radiation syndrome triggered by the fatal substance known as polonium-210 [40]. The British authorities' subsequent investigations into the circumstances of Litvinenko's death resulted in significant diplomatic challenges between the governments of the United Kingdom and Russia. The European Court of Human Rights (ECHR) rendered a verdict in September 2021, determining that Russia bore responsibility for the death of Litvinenko. The European Court of Human Rights (ECHR) has determined, with a high degree of certainty, that Andrey Lugovoy and Dmitry Kovtun were responsible for the death of Alexander Litvinenko. The verdict rendered by the Court aligns with the conclusions drawn from a United Kingdom inquiry conducted in 2016 [41].

#### Challenges of Forensic Evidence

Despite its importance, the utilization of forensic evidence presents several challenges. These challenges can significantly impact the reliability and admissibility of such evidence in court.

**Complexity of Analysis:** One of the primary challenges in forensic science is the complexity of analysis. Different types of evidence, such as DNA, fingerprints, and ballistics, require specialized knowledge and equipment. Errors can occur at any stage of the analysis, and these errors can lead to wrongful convictions [42].

**Human Error:** Forensic analysis is often carried out by humans, and like any other field, human error can be a significant challenge. Mistakes in sample collection, contamination, or misinterpretation of results can have dire consequences.

**Bias and Cognitive Biases:** Forensic experts are not immune to biases, which can influence their conclusions. Confirmation bias, for example, can lead an expert to interpret evidence in a way that aligns with their initial beliefs or the prosecution's theory.

**Backlogs and Resource Constraints:** Many forensic laboratories face backlogs due to resource constraints, leading to delays in the processing of evidence. This can have serious consequences for suspects awaiting trial and can even result in the loss of crucial evidence [43].

**Evolution of Technology:** While advances in technology have improved the accuracy of forensic analysis, they have also presented new challenges. The rapid evolution of technology means that forensic experts must continually update their skills and methods to keep up with the latest developments.

**Chain of Custody:** Maintaining a secure and unbroken chain of custody for evidence is critical to its admissibility in court. If the chain of custody is compromised, the evidence may be challenged.

**Legal and Ethical Challenges:** The legal and ethical dimensions of forensic evidence are intricate and can create complications in trials. Issues related to privacy, consent, and the admissibility of certain evidence can lead to legal challenges [44].

**Public Perception:** The portrayal of forensic evidence in popular media can create unrealistic expectations of its infallibility. This can influence jurors' perceptions and lead to wrongful convictions or acquittals.

**Interdisciplinary Collaboration:** Forensic investigations often require collaboration between different disciplines, such as law enforcement, forensic scientists, and legal professionals. Effective communication and cooperation can be challenging, potentially leading to misunderstandings and errors.

**Standardization and Quality Control:** Standardization of forensic procedures and quality control measures are essential to ensure the reliability and validity of forensic evidence.

### Legal Framework

Forensic evidence aids in the pursuit of justice and the determination of guilt or innocence. In Jordan, a country with a legal system deeply rooted in its history and traditions, the incorporation of forensic evidence has evolved to meet international standards while respecting its cultural and legal framework. The legal framework governing the use of forensic evidence is primarily rooted in the Jordanian Constitution, the Code of Criminal Procedure, and international treaties to which Jordan is a party.

#### The Jordanian Constitution

The Jordanian Constitution lays the foundation for the legal framework surrounding forensic evidence. It guarantees the rights of individuals accused of crimes and enshrines the principles of fairness and justice. Specifically, Article 9 of the Jordanian Constitution states that "The dignity and freedom of the individual shall be safeguarded," emphasizing the importance of respecting the rights of the accused during the criminal justice process [45].

#### The Code of Criminal Procedure

The Code of Criminal Procedure (CCP) is the primary legislative instrument governing criminal investigations and trials in Jordan. The CCP addresses the admissibility, handling, and presentation of forensic evidence in court. It outlines the procedures to be followed by law enforcement agencies and forensic experts when collecting and presenting evidence. Several articles in the CCP directly relate to forensic evidence, including Articles 8, 173, and 174 [46].

- Article 8 of the CCP stipulates that criminal investigations must be conducted diligently, respecting the law and the rights of the accused. This provision ensures that forensic evidence is collected and handled in a manner consistent with the law and fundamental rights.
- Article 173 of the CCP allows for the introduction of forensic evidence in court. It specifies that evidence is admissible if it is relevant to the case and is obtained legally. Furthermore, the article outlines the process for presenting expert witnesses to testify about the forensic evidence collected.
- Article 174 of the CCP empowers the court to order the examination of a defendant by a forensic expert if it deems it necessary for a fair trial. This article ensures that forensic examinations can be performed to establish the innocence or guilt of the accused.

## International Agreements and Treaties

Jordan is a signatory to several international agreements and treaties that influence the use of forensic evidence in criminal cases. The most notable of these is the United Nations Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, to which Jordan is a party. According to Article 2, paragraph 1 of the Convention, every State party, including Jordan, is required to undertake measures aimed at strengthening the prohibition of torture. These measures may take the form of legislative, administrative, judicial, or other acts, with the ultimate goal of effectively preventing torture. In order to guarantee the implementation of effective measures aimed at preventing and penalizing acts of torture, the Convention delineates in future sections the specific obligations that the State party must undertake [47]. This convention obliges Jordan to prohibit and prevent torture and inhuman treatment during the criminal justice process.

## Conclusion

In conclusion, the use of forensic evidence in criminal investigations and trials in Jordan plays a pivotal role in ensuring justice, transparency, and the protection of human rights. While there have been challenges and areas for improvement, significant strides have been made in recent years. Forensic evidence, ranging from DNA analysis to fingerprint examination, has become an indispensable tool for law enforcement agencies in Jordan. It helps establish the guilt or innocence of suspects, identifies perpetrators, and provides critical information for solving crimes. This, in turn, leads to a more fair and efficient criminal justice system. There remain challenges. The backlog of cases awaiting forensic analysis can sometimes lead to delays in the judicial process. Additionally, there is a need for further investment in training and equipping forensic professionals. Ensuring the proper handling and storage of evidence is essential to prevent contamination and maintain its integrity. However, in the courtroom, forensic evidence is used to bolster the prosecution's case, as well as to establish the innocence of the accused. Jordan has witnessed the adoption of more transparent and impartial trial procedures, and forensic experts are increasingly called upon to testify as expert witnesses. This contributes to a more balanced and just legal system.

## Recommendations

There are several areas where improvements and recommendations are needed to enhance the effectiveness of forensic evidence in the Jordanian legal system.

First and foremost, there is a need for increased investment in forensic facilities and technology. To bolster the capabilities of forensic laboratories, Jordan should allocate more resources to acquire state-of-the-art equipment and provide training for forensic experts. This will help expedite the processing of evidence and improve the overall quality of forensic analysis.

Additionally, it is essential to establish clear guidelines and standards for the collection and preservation of forensic evidence. Proper chain of custody procedures should be implemented to prevent contamination and mishandling of evidence. This can help eliminate doubts about the integrity of the evidence presented in court.

Furthermore, Jordan should develop a comprehensive database of forensic evidence, including DNA profiles and fingerprints, to aid in criminal investigations and link suspects to previous cases. This database can expedite investigations and facilitate the identification of repeat offenders.

To ensure the credibility of forensic evidence, the country should also establish an accreditation system for forensic laboratories and experts. This would help build trust in the accuracy and reliability of forensic reports, making them more persuasive in court.

Moreover, there is a need for the judiciary and legal professionals in Jordan to receive specialized training in understanding and interpreting forensic evidence. Judges, prosecutors, and defense attorneys should have the knowledge and skills necessary to effectively assess and present forensic evidence during trials.

Lastly, there should be measures in place to protect the rights of the accused in cases where forensic evidence is presented. This includes ensuring that defense attorneys have access to the same evidence and expert witnesses as the prosecution, and that the accused receives a fair trial.

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