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# The role of artificial intelligence in forensic evidence presentation

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**Abstract**--Artificial intelligence (AI) is refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. This is found to be important in improving effectiveness in Forensic science field. Forensic science is critical to the conviction of the guilty and the acquittal of the innocent and artificial intelligence presents an avenue to accompany the paradigm shift in the relationship between criminal adjudication and forensic expertise. However, it is found that lack of comprehensive review and finding available on how artificial intelligence could enhanced the success and presentation of evidence. Thus, this paper highlights the role of artificial intelligence in forensic evidence presentation focusing on how this technology plays it roles to the establishment of causation, to the laboratory standards, the interpretation in forensic evidence presentation as well as removing the coincidental match in forensic evidence presentation. The main contribution of this study is it provides a framework development of an AI adoption in presenting the DNA evidence. The findings of this framework contribute to a better understanding on the AI adoption in presenting DNA evidence, in which important as a reference to be applied by the police department.

**Keywords**--role artificial intelligence, forensic, evidence presentation, framework.

## **Introduction**

The UAE forensic units operate under the direct auspices of the local police force. Forensics, as pertaining to criminal investigations, only transpires under the watchful eye of the government, without private interference. The number of cases solved at the laboratories across the UAE is not exactly known even though frequent reporting of the laboratory's feats in terms of the number of cases solved, have often gained newspaper attention [1-2]. In 2018, for instance, the Sharjah forensic lab helped solve over 13,000 special cases after processing over 150,000 samples of evidence.

UAE Forensic laboratories play an important role in the technological capabilities of the local law enforcement agencies. According to [2], forensic laboratories also provide the police with continuous development through the use of advanced and environment-friendly equipment. Forensic processes in the UAE remain an integral aspect of the scientific process thought at the police and civil academic institutions. The laboratories also help contribute to the preparation and delivering lectures, holding training sessions, forensic workshops, educating visiting students, alongside other knowledge development needs in the area of forensics [1-2].

In a 2007 interview conducted with the Dubai Police Forensic Laboratory, [3] reports that the forensic lab is an integral aspect of the crime scene documentation and the evidence presentation process. The laboratory deal in two main types of evidence; testimonial and physical. Documentation in the labs is also done in three main methods, using written notes, photographs, and sketches. On the recent introduction of artificial intelligence, laboratory information systems (LIMS) have begun to play an important role to help handle voluminous evidence processing. Moreover, specific procedures are adapted to ensure proper handling, collection, preservation, packaging, transportation, documentation and final presentation of evidence [3]. According to [4], even though significant advancements have been made in the forensic innovation since original introduction, evidence on whether artificial intelligence has enhanced the success and presentation of evidence is very little. [5] add that the success of investigations as facilitated by artificial intelligence in automatic fingerprint systems, advanced computing, including DNA analysis, is lacking. Whereas [6] observe that artificial intelligence has had little impact on many areas of criminal investigations even though others including [7-11] offer detailed and increasing presence of artificial intelligence in evidence presentation. The main significant contribution of this paper is to reveal the research gap on the role of artificial intelligence in DNA witnessing in evidence presentation in order to develop countering strategies framework.

## **Methodology**

In this paper, comprehensive review methodology as per Figure 1 for the effective schemes of artificial intelligence adoption towards evidence presentation is undertaken in order to identify, evaluate and interpret all possible existing research which relate to a specific research question. The review was carried out in two stages. The first stage is conducting review regarding the artificial

intelligence adoption to the DNA evidence presentation which begins with the identification of keywords and search terms indicated by [12][40-41]. For these studies, there are four online research databases selected to search the article, which are Science Direct (www.sciencedirect.com), Research Gate (www.researchgate.net), IEEE Xplore (ieeexplore.ieee.org), Google Scholar (scholar.google.com). The keyword have been highlighted on "DNA Presentation "Artificial intelligence" and "strategy" with the other possible synonyms. Table 1 shows the keyword used to this review.

Table 1: Synonym for keyword searching

WORD	SYNONYM
Adoption of Artificial intelligence Towards DNA Presentation Evidence	
Adoption	Endorsement
	Implementation
Artificial intelligence	Machine learning
	expert system
DNA Presentation	DNA
	Demonstration
	DNA Display

The search string was used based on the keywords of (Adoption OR Endorsement" OR "Implementation") AND ("Artificial intelligence" OR "Automation" OR "Applied Science") AND ("DNA Presentation" OR "DNA Demonstration" OR "DNA Display") to ensure all related the papers are included.

The total of the paper is one hundred and sixty- one. Then each paper was noted and manually examined to determine its relevance to the topic. The selected articles or paper meet the following criteria:

- The research focuses strategies which contributes to adoption of artificial intelligence toward DNA evidence presentation.
- The articles are written in English.
- The articles searched must base on the objective study.
- Article published in both academic and trade journals.
- The focus of majority of articles studied should be published from 2015 to 2020 but the previous article can be accepted as a basic theory or references.

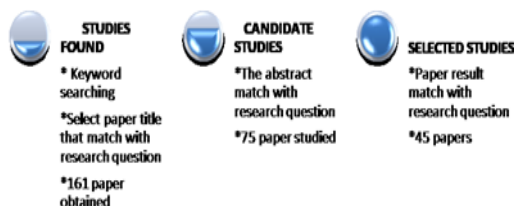


Figure 1: Journal searching for literature review

For the second stage of research method, all the selected articles from the first stage were interpreted and analyzed. The deductive research approach is considered in establishing strong support of empirical evidence by first building on a clear set of theoretically established assumptions on the relationships between the constructs of the study [13][42]. The deductive reasoning is essential to building an existing body of knowledge without having to repeat work already conducted in the area. The deductive research approach flows from the establishment of theory through hypotheses, observation to confirmation/rejection. The extraction of relevant data during this stage is essential in order to synthesize the evidence. The results presentation will be developed into artificial intelligence adoption framework of DNA presentation Evidence. For these reviews, there are several hypotheses are proposed which are:

H1: Artificial intelligence significantly moderates the establishment of causation in the presentation of evidence.

H2: Artificial intelligence significantly moderates laboratory standards in the presentation of evidence

H3: Artificial intelligence significantly moderates the interpretation of DNA results in the presentation of evidence.

H4: Artificial intelligence significantly moderates the removal of coincidence in DNA presentation of evidence.

H5: Artificial intelligence has a positive and significant predictive effect on the presentation of evidence.

H6: The new artificial intelligence model of DNA witnessing step makes a significant improvement in the presentation of evidence over traditional methods.

H7: The new artificial intelligence model makes an improvement to the presentation of evidence with regards to its applicability.

## **Review Discussion**

In evidence presentation, it deals with mixtures that remains a traditional aspect of DNA processing. A connection is usually drawn by taking samples of biological evidence from the victim and suspect to help amplify the DNA by comparing the crime scene samples DNA with that found on the suspect, victim, or both. As explained by [14], DNA from one person cannot contain more than two alleles in each locus. This is in reference to the earlier discussion that the individual is made up of chromosomes in pairs. Nonetheless, in most cases, the swabbed biological evidence usually consists of a mixture of more than one person's DNA. In the event of a mixture, there must be at least 5% of the minor contributor to be considered significant; thus, the chance of finding a mixture is dependent on the proportion of DNA from each contributor [15].

One of the most relevance to the detection of mixtures is the existence of different alleles in the swapped sample [15]. The chance of landing a mixture, therefore, depends on the proportion of mixture between the parties. Ultimately, a mixture should provide enough loci to detect different contributors to the sample. The subject of a mixture may be viewed through a similar lens as contamination, whether in the field or in the laboratory. Unknown mixtures resulting from contamination can lead to misleading and mislabelling results [16]. This has often led to miscarriages of judgement [17]. Contamination compromises a DNBA

analysis and cannot be counted as an outcome of the DNA analysis [18]. Contamination usually occurs for different reasons; these include the packaging of samples with wet stains into the same kit. In the laboratory, contaminations can lead to the artefactual typing results or the incorrect attribution of a DNA profile to a person. Such errors have significant implications for DNA witnessing and criminal proceedings in the law court [17-18].

Due to the seriousness of undue mixtures and contamination, installing measures to guard against such events is a critical aspect of the overall DNA witnessing process [16-17]. According to the [18], contamination, misleading and mishandling of evidence may occur at four main stages for the DNA witnessing process; the first of these is the crime scene, the second is when it is being transported to the laboratory, the third is when it is in the analysis stream in the laboratory, and the final is when the results are being transcribed onto paper. Noting that contamination may occur with all kinds of DNA evidence, this has become of great concern for forensic experts [19]. This situation is worsened as multiple experts have to manage or handle samples from the crime scene until they reach the laboratory and are analysed for DNA witnessing [17].

The lack of direct control of forensic experts of the process of sample management has led to the need to install checkpoints and follows strict guidelines, procedure documentation, and other measures to ensure integrity in sample mixtures, labelling and recording. Other traditional methods used include the retention of sample evidence from the crime scene, to allow for future cross-checking. However, retention of DNA evidence from fixed assets such as walls or sidewalk is not always possible, unlike drawing of extra blood for re-analysis. For immovable objectives, extra swabs may be taken for a re- analysis.

In addition, a fixed chain of custody is critical in the evidence handling process. In several cases, contaminations occur from the addition of another human DNA. This occurs through three main channels; the first is an original mixture obtained from the crime scene; the second is a crime scene sample contaminated in the course of landing either in the field or laboratory, leading to false inclusion; and the third is a carry-over contamination persistent in certain kinds of DNA typing such as PCT-based typing [18].

Considering the challenges associated with contamination and associated resolution strategies currently employed, it remains as part of the present study to introduce a modified approach to DNA treatment which guarantees the analysis of mixtures. This is done through the introduction of intelligent markers that can be used to differentiate mixtures and tell whether a sample has been contaminated at any stage of the sample handing or DNA typing process.

### **Establishing causation for forensic evidence presentation**

The role of artificial intelligence in establishing causation in the presentation of forensic evidence has been supported by key studies presented in the systematic literature review including [21-24]. [21] argued that the use of True Allele for DNA witnessing enhanced the interpretation approach such that causation is easily established. The overarching role of artificial intelligence in this area was

highlighted by the reduced role of humans on the operationalisation of this system. The use of artificial intelligence is critical to prevent the “preponderance of the evidence” where human opinions and non- scientific expert submissions are brought into evidence presentations. A similar argument was raised by [22] on the need to establish causation not only in the removal of coincidence but within the scientific context.

Establishing causation involves scientifically explaining the results of the DNA tests to mean that the evidence presented is true and only true because there was a cause and effect or outcome. In [24] submission, evidence is submitted that causation may be established not only in DNA based witnessing but in other areas of forensic artificial intelligence applications. Literature debates also support that causation is different from coincidence which usually draws on the association with social and cultural attributes surrounding the case or event. Establishing causation, therefore, exists within a thin phase of physical evidence explained by the forensic test results [22-24].

The role of artificial intelligence in establishing causation is vital as causation could be considered more scientific if it goes beyond the capabilities of humans and existing social and cultural explanations. The study will test the moderating of existing artificial intelligence capabilities to strengthen the existing effect of causation on the presanction of evidence. As causation is a critical aspect of evidence presentation, asserting whether or not existing artificial intelligence makes any significant contribution to this area is critical.

### **Laboratory standards in forensic evidence presentation**

Laboratory standards have been observed as one of the key factors that determine the authenticity of evidence presented in the law court [12], [21], [25- 27]. Laboratory standards have been established as one of the critical aspects of objective, replicable, and authentic evidence presentation in the analysis of forensic evidence [27]. Structural and scientific laboratory standards conform to set benchmarks of scientific admissibility when key thresholds are met in forensic analysis.

The relevance of standards to forensic evidence presentation has been established by a number of studies, including [21] on the Frye Standard and the Daubert Standard essential to the admissibility of forensic evidence. The standards are weighed and considered prior to the acceptance of evidence. In the event where the standards are non-scientific, the resulting evidence may equally be considered as unacceptable or not meeting the required standards for the admit the expert evidence. It must be added that whether or not the jury understands the standards for presenting a set of evidence, there may be the need for an additional expert in the area of laboratory support to help explain to the jury the technicalities associated with the lab standards.

[25] argue on the need to consider laboratory standards at the case level; here, the overall processes and activities associated with the case handling. As explained by [25], the case management processes encompass the sample management and other processes surrounding the preparation of evidence for court. The processes

evidence passes through are therefore equally relevant as the outcomes of these evidence used in the law courts. Thus, the need for standardisation of case management artificial intelligence has mainly been forwarded by [12] in all areas of case management including reporting [26] and interpretation methods [27]. Introducing artificial intelligence into laboratory standards will ensure that effective contamination preventive measures are installed, the degree of error is significantly reduced, and that the overall authenticity of the evidence is heightened through flawless evidence establishment processes.

### **Interpretation in forensic evidence presentation**

Interpretation of evidence was observed as one of the most supported constructs in terms of existing evidence in support of how artificial intelligence contributes to the research model. At least fourteen papers in the systematic literature review elaborated on the need to ensure that laboratory standards are objective in playing their individual role in the presentation of evidence in the law court [28-30]. A number of these papers argued in favour of the need for standardisation of interpretation whilst others observed the ability of interpretation to arrive at meaningful evidence to support DNA witnessing.

Whilst the laboratory environment provides the space within which DNA profiling and other activities are performed by DNA experts; actual interpretation is key to support evidence presentation. Interpretation is guided by key standards, metrics, and other knowledge enacted processes that help arrive at meaningful results from all processes associated with DNA witnessing. With the advent of network-based interpretation and cloud computing, [28], assert that interpretation may not necessarily be restricted to physical components within the laboratory but the overall capabilities of the laboratory to utilize existing online and offline channels available to it. Ensuring that standards in the form of specific benchmarks are met in the event of interpretation, standards used in the court witnessing can help create legal benchmarks for ruling and legal references [29]. An instance is that if key interpretation standards have proven suitable in earlier cases, they may be considered more authentic or as benchmarks that must be met for judgement to be passed.

It must be added that interpretation has a more robust and definitive relationship with regards to how artificial intelligence helps improve the presentation of evidence. [30], for instance, explain this from the use of artificial intelligence to help interpretative reliability of forensic evidence in forensic laboratories. Within the laboratory environment, a number of artificial intelligence systems and software have been argued as playing an important role in the interpretation of forensic evidence. Some of these artificial intelligence systems include the STR Mix proposed by [27], Life Technologies proposed by [12] and general technologies for interpretation as proposed by [26]. Others, including [19] argued that e-learning artificial intelligence is critical to improving interpretation in the presentation of evidence.

### **Removal of coincidental match in forensic evidence presentation**

Removing coincidence is central to the presentation of evidence, in a similar manner as the establishment of causation. With about four papers supporting this area in the systematic literature review, removing coincidence may not necessarily do with the use of artificial intelligence, as originally argued by [31]. Due to knowledge about the external environment, assumptions about how crimes occur may find their way into the presentation of evidence without proper scientific backing, leading to a miscarriage of justice. Even though such assumptions or coincidences may not always be false, it is critical that a direct cause and effect relationship is proven scientifically so as not to depend on these assumptions. [22] argument in favour of uncertain causation, establishes that artificial intelligence plays a very important role in ruling out coincidences by establishing some form of causation. In another observation by [32], coincidence is seen as a key factor that comes into consideration when law enforcement, forensic experts, and other legal entities fail to arrive at critical evidence in support of specific outcomes. [33] argued that tendency evidence must be considered separate and unique from coincidence evidence in criminal trials. The lack of evidence within a given criminal situation fuel heterogeneous constructivism of DNA artificial intelligence in presenting evidence. In the event where causation cannot be established, removing coincidence with the help of artificial intelligence becomes critical to the presentation of evidence [33].

### **The role of artificial intelligence in forensic evidence presentation**

In the earlier discussions, artificial intelligence was observed as a critical moderating factor on the effect of causation, laboratory standards, interpretation, and coincidence on the presentation of evidence in the law court. Artificial intelligence adoption was earlier discussed as essential to the performance of key duties within any given environment [34-36]. The non-usage of artificial intelligence systems implies that the desired outcomes will not be achieved. Artificial intelligence defined in the construct, therefore, represents the given artificial intelligence and its adoption, usage or application for specific tasks within the forensic environment.

It may be observed that the different artificial intelligence systems support different aspects of evidence presentation [11],[21], [26-28], [32], [37]. No single artificial intelligence system has been clearly argued in the context of how it supports all the four main antecedents of evidence presentation adapted in the present study [38]. However, this study attempts to cement the argument that exiting artificial intelligence should have the capacity beyond that humanly achievable. Artificial intelligence must be able to take a step towards evidence presentation and not simply aid in interpretation for forensic experts to connects the dots. It is in line with these arguments that the new AI artificial intelligence was examined in view of all these antecedents

### **Framework Development**

Based on these assertions and evidence supplied through the systematic literature review, the role of artificial intelligence in enhancing the overall

contribution of causation to the presentation of evidence is follow the first hypothesis proposed. In addition, the second hypothesis also accepted which is consider the moderating effect of artificial intelligence on the role of laboratory standards in the presentation to evidence. Given the overwhelming support for evidence on the role of artificial intelligence in interpreting evidence for DNA witnessing, the third hypothesis of the study is established also accepted. Ultimately, artificial intelligence should be able to rule out coincidence in the presentation of evidence by explaining why specific causal relationships may not exist as assumed which is in line with hypothesis 4. In support of the direct contribution of artificial intelligence to the presentation of evidence, this section is in support of the last three research hypotheses. These hypotheses surround the ultimate role of artificial intelligence in the evidence presented as well as the extent to which current artificial intelligence of DNA witnessing compares with the new artificial intelligence under experimentation which all of them are accepted.

The proposed research model is presented in Figure 2. Emphasis is placed on the reference guide areas to DNA Evidence and how artificial intelligence can help improve upon these methodological areas in the reliable presentation of evidence as presented by the [39]. Literature support on these forensic DNA methods with regards to their contribution to the presentation of evidence is established in support of these associations. The first of these relationships has to do with the effect of causation on the presentation of DNA witnessing evidence, given the moderating role of artificial intelligence. For the second hypothesis, the moderating role of artificial intelligence on the impact of laboratory standards on evidence presentation is hypothesised. The last two main antecedents include the effect of interpretation and removal of coincidence. These hypotheses are directed at the presentation of evidence, given the moderating role of artificial intelligence. For the last group of hypotheses on the effect of artificial intelligence on evidence presentation, the comparison of traditional artificial intelligence with the new AI artificial intelligence, and the contribution of the new AI artificial intelligence to the presentation of evidence, are as well hypothesized as presented in Figure 2. Aside from H1 to H5, H6 and H7 are observed as part of the experimentation of the study.

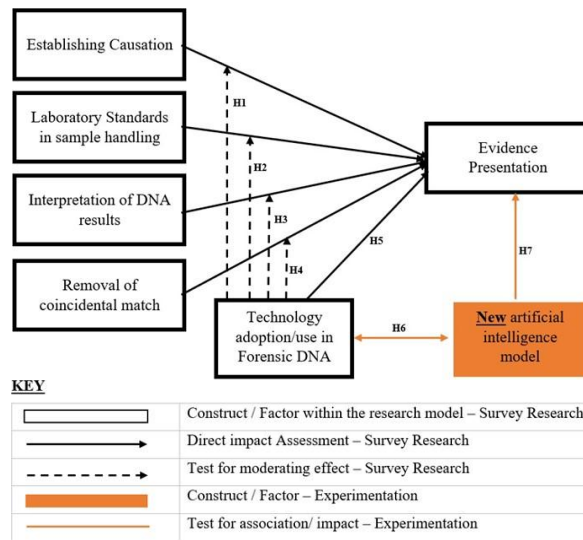


Figure 2: Adoption of Artificial intelligence Toward Evidence presentation Framework

**Conclusion**

As a summary, the literature reviewed revealed that artificial intelligence has an important role to play in the establishment of causation, improvement of laboratory standards, interpretation in DNA witnessing, and removal of coincidence, which is essential for evidence presentation process. For the future research, the study perhaps should also focus for a case study to be used to each reflect how the new artificial intelligence would make a difference in earlier cases where there were misjudgments. There is the need to clearly specify how the artificial intelligence can help establish causation, how it can help improve laboratory standards in the legal case to meet the needed judiciary requirement, the degree to which it can help remove coincidence, and the degree of interpretation capable of arriving at salient contribution to evidence presentation. The findings in this article should contribute on comprehensive understanding on the artificial intelligence adoption in DNA evidence presentation.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

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