

How to Cite:

Altayari, W., & Kamalrudin, M. B. (2022). Antecedents of DNA-based method to improve the presentation of forensic evidence: An exploratory study of UAE DNA forensic laboratory. *International Journal of Health Sciences*, 6(S2).
<https://doi.org/10.53730/ijhs.v6nS2.6427>

Antecedents of DNA-based method to improve the presentation of forensic evidence: An exploratory study of UAE DNA forensic laboratory

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Abstract---Forensic science is critical to the conviction of the guilty and the acquittal of the innocent. Technology is found could increases the speed and efficacy of forensic work, yet still uncertain to maintain or enhance the quality of forensic work for the presentation of evidence. Further, no comprehensive study found on role and type of antecedents of DNA-based methods in enhancing the success and presentation of forensic evidence. Thus, the aim of this paper is to present the significant antecedents of DNA-based method, build up from two theories called scientific theories of forensic evidence and Social theory. The results are based on the survey related to the role and type of antecedents of DNA- based method towards the presentation of forensic evidence that was conducted in the United Arab Emirates DNA Forensic laboratory. This paper study uses questionnaires as the principal data collection instrument for testing the five hypotheses and five significant antecedents found are; 1) establishment of the causation 2) laboratory standards, 3) interpretation, 4) removal of coincidental match and, 5) the role of technology towards evidence presentation. All these findings, are believed provides contribution to existing knowledge of scientific theory to forensic evidence and practice of forensic activities.

Keywords---DNA-based method, presentation evidence, role AI technology.

Introduction

The increasing number of high-profile forensic evidence failures, together with the growing critique of the literature on forensic methodologies draw attention to questions regarding the fundamental ideologies of forensic science. The very suitability of forensic evidence within the criminal justice systems remains questionable [1-3]. A paradigm shift in the relationship between criminal adjudication and forensic expertise is being experienced, and this, together with law reforms are bringing forensic sciences and expert advice to a somewhat challenging level [3]. This is due to the nature of the evidence presentation, which dealing with mixtures, leads a traditional aspect of DNA processing to be tedious and complex and prone to errors of interpretation. This is because, as explained by Ponizovskiy (2017) [4], 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 [5]. Of most relevance to the detection of mixtures is the existence of different alleles in the swapped sample [5]. A mixture also 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 mislabeling results [6]. This has often led to miscarriages of judgment [7]. Contamination compromises a DNBA analysis and can't be counted as an outcome of the DNA analysis [2]. 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 art factual 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 [2, 8, 9].

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 [9, 10]. According to the [2], 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 [9]. 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 [11].

The lack of direct control of forensic experts of the process of sample management has led to the need to install checkpoints and follow strict guidelines, procedure documentation, and other measures to ensure integrity in sample mixtures, labelling and recording. Other traditional methods used to allow for future cross-checking, include the retention of sample evidence from the crime scene [9]. 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 ^[12].

Considering the challenges associated with contamination and associated resolution strategies currently employed, it remains as a part of the present study to introduce a modified approach to DNA treatment, which guarantees the analysis of mixtures ^[13]. 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 handling or DNA typing process. This process remains critical; hence, there is a need to address the main challenge of DNA witnessing by ruling out contamination with the highest level of surety and little to no chance of error in dealing with contaminations. These efforts remain as a part of the broader effort to step up the authenticity of DNA evidence presentation. Hence, there is a need to identify the type and role of antecedents that significant to the success of a forensic evidence.

In the study presented here, the focus is on forensics DNA technologies useful to the presentation of DNA evidence in the law court. Mainly, areas of focus include methodologies associated with the interpretation of DNA evidence, improvement of laboratory standards, removal of coincidence, and establishment of causation which are also the type of antecedents found. Addition to this, technology and interpretation are also found to be the type of important antecedents towards the presentation of the forensic evidence.

This study is also contextualized among the DNA labs in the UAE. Specifically, two leading forensic DNA labs are considered in the present investigation; the Forensic Biology Laboratory of the Forensic Evidence Department at Abu Dhabi Police and the Forensic Laboratory of the General Department of Forensic Science and Criminology Headquarters established by the Dubai Police. These two labs are equipped with technical and technological amenities as well as state of the art equipment of international standards ^[14]. At the heart of operations are the local Emirati talent and international professionals working together to achieve critical strides in forensic science. The other Emirates have forensic laboratories set up to handle similar tasks and activities even though the top two laboratories are those that operate in Abu Dhabi and the Dubai Emirates. Collaboration with the two leading labs often occurs across the Emirates when high-profile forensic cases are encountered.

Apart from forensic DNA, the labs leverage the benefits and capabilities of forensic chemistry, forensic toxicology, trace evidence and post-bomb and explosives and other acute aspects of forensics such as digital forensics, forensic video, fire, arson, and fingerprints to aid in various investigations. In 2015, the Forensic Biology Laboratory of the Forensic Evidence Department at Abu Dhabi Police was

one of only three labs across the globe to achieve a 100% match in DNA profile of a 150 years old bone powder sample to identify the first sample approximately 400 years old [15]. The labs and the human resource expertise in the top two labs have often served the larger interest of the UAE, GCC, Middle East and the globe with regards to forensic.

The remainder of this paper is organized as follows. Section 2 discuss the literature review that covers on existing works and type of antecedents involve to ensure the success of forensic evidence and Section 3 discuss the theory building and section 4 discusses the methodology applied to conduct the quantitative survey. Section 5 discusses on the data analysis and Section 6 discuss the results of the evaluation. Finally this paper concludes with a summary and future work options.

Literature Review

This section is a review on the existing works and the important variables that become the challenges DNA-based evidence. The process remains critical and revolutionizing to the main challenge of DNA witnessing by ruling out contamination with the highest level of surety and little to no chance of error in dealing with contaminations. These efforts remain as part of the broader effort to step up the authenticity of DNA evidence presentation and ensure that technology has a significant addition in terms of the contribution of causation, interpretation, removal of coincidence, and laboratory standards to the presentation of evidence.

Establishing causation for forensic evidence presentation

The role of technology in establishing causation in the presentation of forensic evidence has been supported by key studies presented, including Grix (2010), Hamer (2017), Kiely (2005) and Kitchenham(2007) [16-19], that argued on the use of True Allele for DNA witnessing to enhance the interpretation approach as it is found to be easily established. The overarching role of technology in this area was highlighted by the reduced role of humans on the operationalization of this system. The use of technology 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 Kloosterman (2007) [20], on the need to establish causation not only in the removal of coincidence but within the scientific context.

Establishing causation involves scientific explanation of the results of the DNA tests that the evidence presented is true and only true because there is a cause and effect or outcome. Based on the study by Kassin et al. (2013)[21], asserted submission is evidence that causation may be established not only in DNA based witnessing, but also in other areas of forensic technology 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 [12, 13]. The role of technology 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.

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 [22–26]. Laboratory standards have been established as one of the critical aspects of objective, replicable, and authentic evidence presentation in the analysis of forensic evidence [25]. Structural and scientific laboratory standards conform to set benchmarks of scientific admissibility, when key thresholds are met in forensic analysis. These benchmarks and standards must not only be scientific, but they must just as well be standardised and comparable across laboratories. Deviations or differences in forensic standards are therefore often scrutinized for upgrades or comparable level performance to enable the acceptance of such expert witness' contribution to any existing criminal proceedings.

The relevance of standards to forensic evidence presentation has been established by a number of studies, including Fonnelop(2016) [23], 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 expert evidence. It must be added that whether or not the jury understands the standards for presenting a set of evidence, there may be a need for an additional expert in the area of laboratory support to help explain to the jury regarding the technicalities associated with the lab standards.

Based on the study by Frost (2019) [24], argued for the need to consider laboratory standards at the case level namely, the overall processes and activities associated with the case handling. As explained by Gerrodette (2011) [26], 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 technology has mainly been forwarded by Lovrich et al. (2003) [27], in all areas of case management, including reporting [22] and interpretation methods [23].

Interpretation in forensic evidence presentation

Interpretation of evidence was observed as one of the most supported constructs in terms of the existing evidence that support the contribution of technology to the research model. There are few works elaborated the need to ensure laboratory standards play their objective role in the presentation of evidence in the law court [28–30]. A number of these papers argued in favor of the need for standardization 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 the key

to support evidence presentation. Interpretation is guided by key standards, metrics, and other knowledge enacted processes that help to arrive at meaningful results from all processes associated with DNA witnessing. With the advent of network-based interpretation and cloud computing ^[29], asserted that interpretation may not necessarily be restricted to physical components within the laboratory, but it also encompasses 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 ^[28]. For example, if key interpretation standards have proven suitable in earlier cases, they may be considered more authentic or as benchmarks that must be met for judgment to be passed.

It must be added that interpretation has a more robust and definitive relationship with regard to how technology helps improve the presentation of evidence. Tober (2011)^[31], explained this from the use of technology to help interpretative reliability of forensic evidence in forensic laboratories. Within the laboratory environment, a number of technology systems and software have been argued as playing an important role in the interpretation of forensic evidence. Some of these technology systems include the STR Mix, proposed by Carrecedo and Prieto (2018) ^[30]. Life Technologies, proposed by Machado(2020)^[28], and general technologies for interpretation, as proposed by Frost (2019)^[24]. Others, including Carifio and Perla (2007) ^[32], argued that e-learning technology 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. In relation to the four papers supporting this area in the systematic literature review, removing coincidence may not necessarily be achieved through the use of technology, as originally argued by Carifio and Perla (2007) ^[32]. 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 that the dependence on these assumptions can be avoided.

Mortera (2019) ^[33], who were in favour of uncertain causation, established that technology plays a very important role in ruling out coincidences by establishing some forms of causation. In another observation by Tuncbag et al. (2016) ^[34], 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. Tuncbag et al. (2016) ^[34], 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 technology in presenting evidence. In the event where causation cannot be established, removing coincidence with the help of technology becomes critical to the presentation of evidence ^[34].

The role of technology in forensic evidence presentation

In the earlier discussions, technology 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. Technology adoption was earlier discussed as essential to the performance of key duties within any given environment ^[34–36]. The non-usage of technology systems implies that the desired outcomes will not be achieved. Technology defined in the construct, therefore, represents the given technology and its adoption, usage or application for specific tasks within the forensic environment.

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

Theory Building

This study is build based on two theories: 1) Scientific theories of forensic evidence and 2) Social theory: Theory of the crime

i) Scientific theories of forensic evidence

The main theory underlying DNA extraction and amplification and overall DNA analysis is scientific knowledge ^[38]. Here, it is asserted that science is a process through which the natural world is examined, and essential truths are discovered. In a single phrase, it is claimed that “the essence of science is the scientific method” ^[2, 18, 38]. Although this position is claimed as objective and structural, a number of challenges have been encountered. The question remains as to what represents the term of ‘scientific method’. In this area, a number of attempts have been made and continued to be made with regard to how science works or how it ought to work. In addition, even though it is often considered that science ensues without prejudice, this is not often the reality. The rejection of this position is often based on the premise that everything about how science is established is based on certain methods, processes, and what we currently know about the world ^[2, 26]. Even though this has often been criticised in the area of social sciences, it is originally traced to the natural application of science such as forensics ^[26].

Considering evidence is based on what is currently known, and the assumptions about the world, the scientific method commences from what is already known to test key hypotheses ^[38]. Nonetheless, key criticism is that many things in the world also exist that cannot be observed at all. These ranges from force fields to complex molecules that cannot be seen using the normal eyes or existing technology. This further leads to the argument that the fundamental aspects of nature cannot be explained without some forms of justification on why the particular evidence is

being observed, and why it is worth observing ^[2]. If evidence is established, it must be based on observable material that can be objectively proven.

To support the establishment of evidence, Karl Popper's Falsification Theory has also gained roots that the source of theory cannot be supported or defined ^[39]. However, once the theory is discovered, it becomes the duty of the scientists to extract necessary insight from the identified theory to arrive at logical conclusions and predictions ^[39, 40]. These conclusions are tested in an experiment environment, and when shown not to be correct, invalidate the theory. In other words, theories are not proven right but are only rejected based on the support of evidence to any given hypotheses. Due to this observation, Wilkinson (2013) ^[40], asserts that scientific progress is made only when good ideas are proven wrong and not when they are proven right.

ii) Social theory: Theory of the crime

The social theory of the crime has often been used as an explanation for heightened and reduced incidence of criminal activities within a given territory ^[41]. This theory asserts that the social environment is the principal cause of criminal behaviour ^[42]. These include broken family and relational bonds. Moreover, it asserts that people engage in criminal behaviour because they do not see the benefits of adhering to conventional social values. To resolve criminal behaviour in this context, positive alternatives are promoted within a given society. The government may intervene and launch social programs directed at achieving positive behaviour. These social programs can help change the cultural conditions that facilitate criminal activities. Others have established that social crime can also be removed through the alleviation of poverty ^[43].

The theory of the crime has also been taken from the interactionist perspective that the association between criminals' fuel criminal behaviour ^[6]. The lack of individual self-direction may spur the tendency of people to associate themselves with others, and this defines specific social roles, which such an individual would more willingly accept as part of his or her social standing. From this perspective, the theory of the crime stipulates that the individual has the power to change his or her own behaviour without any external influence ^[41]. Moreover, creating different opportunities for social interaction with elders and other positive individuals may lead to the consideration of lawful and productive behaviour by these individuals. Seen from the biological perspective, the basics of human interactions come into the debate of how genetics inform deviant behaviour ^[44, 45]. According to Fishbein (2017)^[44], this remains the basic determinant of human behaviour as genes are passed on from one to the other. Mainly the human DNA, environmental, biological contaminants such as nutrition and trauma have the potential to lead to radical behaviour. Others include pre-birth contaminants, such as alcohol and drug abuse among pregnant women have been associated with post-birth deviant behavioural norms. Historically, a radical solution to genetically induced criminal behaviour was to sterilise criminals to prevent them from having offspring ^[41]. However, recent efforts have been directed at encouraging research into this area to help curb genetically induced criminal behaviour.

The last perspective to the theory of crime is the classical approach. This position stipulates that crime is caused by the individual based on his or her free will, without the interference of any external factors or contributors ^[46]. Here, crime simply represents an immoral form of behaviour that is popularly associated with a weaned society. This position also stipulates that crime can be curbed through punishment in a swift and certain manner such that criminal acts do not go unpunished. This position emphasizes the need to award punishments as the simplest and most commendable solution to crime ^[47].

The sociological, interactionist, biological and classical perspectives to social order theory attempt to explain criminal behaviour from diverse perspectives. These positions do not just explain criminal behaviour but attempt to explain what solutions are most recommended to curb such criminal acts. Depending on how criminal behaviour is theorised in this area, the resolution to curb such behaviour may be different. The social theory of the crime may not explain the scientific methodology behind forensic evidence and DNA witnessing, but explain the main objective DNA application to legal proceedings.

Methodology

Data Collection

For the purpose of this study, a survey research strategy together with experimentation of the developed artificial intelligence model in DNA witnessing were considered. The survey research strategy focuses on the DNA experts in the Forensic Biology Laboratory of the Forensic Evidence Department at Abu Dhabi Police and the Dubai Forensic Laboratory of the General Department of Forensic Science and Criminology Headquarters. For the purpose of objectiveness and replicability of the study methodology, the quantitative research method plays a leading role in line with the positivist position, as justified by ^[48].

Here, a survey questionnaire was used as the principal data collection instrument for the quantitative study; this strategy was used to answer the Research questions and hypothesis one to five (H1 to H5) as shown in Table 1.

Table 1 : List of Hypotheses

No.	List of Hypotheses
H1	Establishment of causation influence the presentation of evidence.
H2	laboratory standards influence the presentation of evidence
H3	DNA results influence the presentation of evidence.
H4	Removal of coincidence influence the presentation of evidence.
H5	Technology influence the presentation of evidence.

The questionnaire was placed on an online data collection platform and administered to selected respondents through their respective email addresses. Specifically, the questionnaire was mounted on Survey Monkey Online data collection platform and administered to respondents as recommended by Rodrigues et al. (2017) ^[49]. Data collection was completed over a period of six weeks, as originally anticipated. As part of the present study, a pilot study was

conducted on the survey element to validate the data collection instruments and to test for its reliability.

Data Analysis

The Structural Equation Modelling (SEM) approach for quantitative data analysis was applied with the help of SMART PLS, as recommended by Cook et al. (2002) [50]. Version 3 of SMART PLS was used. SMART PLS worked best over IBM SPSS AMOS since the sample size is below 200 and SMART PLS has been observed to work best in such sample limitation context [51]. As observed, the entire population for the survey research is just about 50; with the PLS-SEM capable of analysing a sample of 30 and above, the minimum threshold for PLS-SEM was met.

A bootstrapping sample of 5000 was generated for the final SEM being generated. The 5000 samples used help validate the sample outcome to reveal the true effects or strengths of the various relationships [52, 53]. The bootstrapping therefore, played a fundamental role in helping to ensure that the study results are validated beforehand due to the small nature of the original sample considered. The use of bootstrapping analytical technique helps to resample and estimate statistics on the population by resampling the dataset with replacements [54]. The Bootstrapping test presents itself as a validator approach to small sample predictions. The main benefit of this method is the ability to simulate samples from a very small sample, and the improvement of results by increasing resample size. This helps to reduce significantly sampling error and affirm the stability of the results of the study [55].

Results

Model Indices and Local Tests

Other local tests were conducted to observe the model fit indices for the saturated and estimated models. Whereas the saturated model considers the main sample of the study, the estimated model considers the sampled cases for the bootstrap test in Table 2. The model fit indices were generally lacking with regard to the set thresholds. There are variety of factors, including the sample size, the number of constructs, and overall depth of the data.

Table 2: Model Fit Indices

	Saturated Model	Estimated Model	Needed Threshold	Remarks
SRMR	0.157	0.157	<0.08	Threshold not met
d_ ULS	11.480	11.494	Within CI	Score not within CI
d_ G	8.646	8.634	Within CI	Score not within CI
Chi-Square	1,300.183	1,300.325	n/a (n.s)	n/a
NFI	0.319	0.319	> 0.95	Threshold not met

Note: CI = confidence interval; d_ ULS = squared Euclidean distance; d_ G = geodesic distance; NFI – Normed Fit Index

The overall test for prediction was observed using the R-squared statistic. The R squared statistic of .949 was high, with an adjusted R squared statistic of .937. The f-squared statistic in Table 3, as a measure of effect size was also statistically significant for all the predictors within the model in Table 4.

Table 3: R Squared Statistic

	R Square	R Square Adjusted
Evidence Presentation	0.949	0.937

Table 4: F-Square Statistic – Effect Size

	Evidence Presentation
Causation	0.328
Coincidence	0.499
Interpretation	0.686
Lab Standards	0.448
Technology	0.486

The loadings for the various factors are presented in Table 5. All the factors for the different items within the framework were significant at a $p < 0.05$ significance level. Even though the loadings were generally above 0.5, two loadings, each for causation and laboratory standards, were below 0.5, but statistically significant at a $p < 0.05$ significance level.

Table 5: Factor Loadings

	Causation	Coincidence	Evidence Presentation	Interpretation	Laboratory Standards	Technology
S21_1	0.717*					
S21_2	0.803*					
S21_3	0.517**					
S21_4	0.608**					
S21_5	0.543*					
S22_1					0.800*	
S22_2					0.706*	
S22_3					0.589*	
S22_4					0.564*	
S22_5					0.541*	
S23_1						0.774*
S23_2						0.656*
S23_3						0.829*
S23_4						0.833*
S23_5						0.423**
S24_1		0.848*				
S24_2		0.855*				
S24_3		0.817*				
S24_4		0.837*				
S24_5		0.712*				

S31_1			0.934*		
S31_2			0.882*		
S31_3			0.888*		
S31_4			0.815*		
S31_5			0.414**		
S41_1		0.622*			
S41_2		0.781*			
S41_3		0.681*			
S41_4		0.757*			
S41_5		0.770*			

Note: * significant at $p < 0.01$ significance level; ** significant at $p < 0.05$ significance level.

As a summary for the local test results, it is found that overall variance in the dependent variable was exceptionally high, together with the statistically significant effect sizes for all the antecedents within the model. The original model fit indices were however, generally lagging. The overall implications of these observations must be observed and discussed as part of the main findings of the study.

Structural Model

The structural model is presented in Figure 1. The model, based on which the earlier quality criteria, validity, reliability and other analysis were conducted, is presented as the moderated model below. The model has five main predictors and four different tests for moderation. This model act as an emphasis is placed on the testing of the first five hypotheses. Within the model, the regression weight is presented together with the statistical significance of the weight. The factor loadings, R squared statistics, effect size statistic (f squared), and other model fit indices presented are all in support of this model in Figure 1. The model is the results of a bootstrap test of 5000 samples using SMART PLS Analysis program.

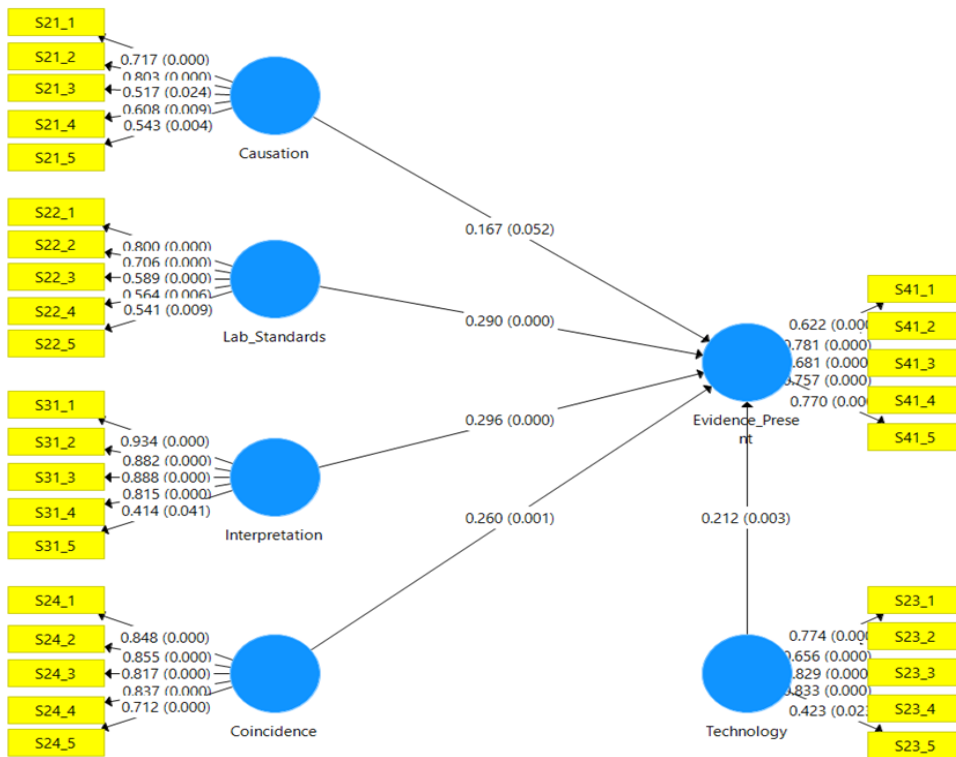


Figure 1: Structural Final Model

Hypothesis Testing

The test results of the hypotheses of the study are presented in this section. A summary of the findings from the coefficients table is presented in Table 6. For all the test for moderation, a direct effect was estimated as part of the model results as presented in Table 6. The research hypotheses results are summarized in the table 7.

Table 6: Path Coefficients

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Causation -> Evidence Presentation	0.176	0.166	0.089	1.980	0.048
Coincidence -> Evidence Presentation	0.291	0.304	0.094	3.109	0.002
Interpretation -> Evidence Presentation	0.295	0.291	0.090	3.287	0.001
Lab Standards -> Evidence Presentation	0.282	0.274	0.088	3.213	0.001
Technology -> Evidence Presentation	0.208	0.191	0.074	2.821	0.005

Table 7: Research hypotheses summary (H1-H5)

Hypotheses	Results	Remarks
H1	Direct effect significant ($\beta = 0.176$, $p < 0.05$);	Accepted
H2	Direct effect significant ($\beta = 0.291$, $p < 0.01$);	Accepted
H3	Direct effect significant ($\beta = 0.295$, $p < 0.01$);	Accepted
H4	Direct effect significant ($\beta = 0.291$, $p < 0.01$);	Accepted
H5	Direct effect statistically significant ($\beta = 0.208$, $p < 0.01$).	Accepted

Both the structural model and hypotheses testing revealed that all the antecedent factors have a significant role in the presentation of evidence. This is also supported through the positive results found from the hypothesis testing as per discussed below:

H1 Establishment of causation influence the presentation of evidence.

For the first research hypothesis, findings from Table 6 and 7 indicated that causation plays a significant role in evidence presentation for DNA witnessing ($\beta = 0.176$, $p < 0.05$); and thus the hypothesis is accepted.

H2 laboratory standards influence the presentation of evidence

For the second research hypothesis, the results indicated that laboratory standards play an important role in evidence presentation ($\beta = 0.291$, $p < 0.01$); and thus the hypothesis is accepted.

H3 DNA results influence the presentation of evidence.

For the third research hypothesis, the results indicated that interpretation play an important role in evidence presentation ($\beta = 0.295$, $p < 0.01$); and thus the hypothesis is accepted.

H4 Removal of coincidence influence the presentation of evidence.

For the fourth hypothesis, the results presented in the SEM analysis indicated that the removal of coincidence plays an important role in evidence presentation ($\beta = 0.291$, $p < 0.01$); and thus the hypothesis is accepted.

H5 Technology influence the presentation of evidence.

For the fifth hypothesis, findings indicated that technology plays an important role in evidence presentation ($\beta = 0.208$, $p < 0.01$); and thus the hypothesis is accepted.

All these findings, provide strong contribution to existing research, mainly from the perspective of scientific theory to forensic evidence^[2, 18, 26, 38]. Like other studies in support of the scientific literature to forensic evidence, the study builds on what is known to achieve the unknown. A large number of technology systems have been proposed for DNA profiling and fingerprinting. However, the area of DNA witnessing requiring the human validator heightens the subject of contamination to its highest level of relevance. In the presentation of evidence for criminal proceedings, any such false evidence or unidentified mixtures can lead to the misappropriation of justice. Such events nullify the very purpose of the forensic units in supporting evidence presentation. The results of the study, therefore, contribute to the practice of forensic activities in support of law enforcement ^[38, 44].

The theory of the crime may as well be drawn into perspective. Considering criminal activities are undesirable within any given society, and criminals are often illusive submitting evidence for judiciary proceedings, it is important that measures are installed to facilitate DNA evidence presentation ^[46, 47]. This theory also is believed support the original scientific theory to forensic work.

Conclusion

This paper significantly contributes the insight on the antecedents for the presentation of evidence. It shows a significance quantitative results for each antecedents such as causation, laboratory standards, evidence interpretation, the removal of coincidence and role of technology towards evidence presentation. This study is believed could contribute to the practice of DNA witnessing in evidence presentation. The results will help minimize on the staff in DNA witnessing. Mainly, it will help alleviate the role of humans in validating forensic evidence. Addition to this, it will also help to remove contamination errors in DNA witnessing. This will improve the possibility of establishing causation, improved interpretation, and managing laboratory standards more effectively.

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