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# **A study on the use of technology to moderate causation and laboratory standards in evidence presentation**

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**Abstract**--In forensic evidence presentation, the presence of technology is essential. Forensic science is critical to the conviction of the guilty and the acquittal of the innocent and science and technology presents an avenue to accompany the paradigm shift in the relationship between criminal adjudication and forensic expertise. Currently, there is no comprehensive review to identify the use of technology to moderate causation and laboratory standards in evidence presentation. This paper provides an overview of significant contexts on how accusation establishment and laboratory standard by technology implementation will impact the evidence presentation thorough analysis on literature studies that involve on articles study that related to evidence presentation. Based on author findings, there are four key-reason how establishing causation impact of evidence presentation and there are five key standardization contexts through the use of technology. The result will gives benefit in term of depth understanding or as a good reference for both academician and forensic practitioner.

**Keywords**--use of technology, moderate factor, causation, laboratory standards, evidence presentation.

## **Introduction**

A number of pitfalls, challenges and solutions have been observed in this arena, and this continues evolving on the increasing role of technology in evidence presentation (Santos, 2014). Kloosterman et al. (2015) on the heightened role of modern technology in forensic investigations, emphasized the role of recent technology developments in availing new possibilities to perform structural and scientific measurements within laboratory environments. Even though technology increases the speed and efficacy of forensic work, it is uncertain whether the quality of forensic work outcomes can be guaranteed in the presentation of evidence (Kloosterman et al., 2015; Baier et al., 2017).

The importance of technology in the presentation and visualisation of evidence in law courts has been highlighted in previous studies (Baier et al., 2017; Lovgren, 2004). There is no doubt that predominant technologies available in criminal investigations are focused on the identification, arrest and convicting perpetrators (Lovgren, 2004). The role of technology systems has, therefore gained roots on the increased sophistication of criminal activities. Questions relating to the basic ideologies of forensic science have been raised given the extensive criticisms of methodologies employed in forensic studies, as well the increasing failures in several high-profile forensic evidence. The very suitability of forensic evidence within the criminal justice systems remains questionable (Nieman, 2009; National Research Council, 2011; Roberts, 2015). Presently, there is a paradigm shift in the association between forensic expertise and criminal adjudication. These events in combination with law reforms have heightened the challenges faced by forensic sciences and experts (Roberts, 2015).

One area that provides an avenue for forensic science to redeem its collapsing image is the strengthening of the role of science and technology to reduce subjective interpretations in expert opinions (Kloosterman et al., 2015). According to Rt (2015), technology pushes the boundaries of forensic sciences and present novel ways of establishing forensic evidence. Ultimately, the legal implications for a more robust forensic science evidence welcome technology as a means to push the boundaries of forensic science and ensure increased acceptability of evidence by the jury (Rt, 2015). Saks & Koehler (2015) admits that technology and scientific forces are revalorising the traditional forensic identification sciences in the paradigm shift highlighted by Roberts (2015).

On the heightened role of technology in forensics, forensic innovation efforts are being used to arrive at novel methods that can be seamlessly applied in the criminal justice system (Kloosterman et al., 2015). Despite these acknowledgements on the need for complex devices, methods, and technological requirement in the presentation of comprehensive evidence, the exact efficiency of technology application over conventional and traditional forensic methods have not been observed (Wilson et al., 2011). This gap is further described in the section that follows and informs the unique contribution of the present study to the body of knowledge. These studies have focused on establishing causation and supporting laboratory standards for presentation of evidence. Upon the systematic literature review, it was found that no known study had empirically

observed expert perceptions on the role of technology in these four areas, to aid in DNA witnessing for the presentation of evidence.

### Research Method

This study entailed an SLR that was performed following the original guidelines proposed by Kitchenham(2007 and Yahya et al. (2013). The SLR was executed in three phases: (2.1) the planning phase (2.2) literature review phase, and (2.3) Reporting phase. Each phase and the corresponding activities are summarized in Figure 1. The tasks undertaken in each phase is described in the next section.

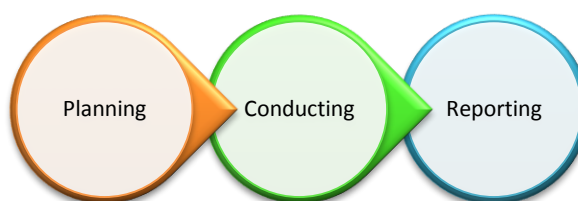


Figure 1. Three Phase of Systematic Literature Review

#### Planning the SLR Research question

In order to achieve the SLR objective and answer the main research question, specific research questions must be answered. These research questions were formulated using the Population, Intervention, Comparison Outcomes and Context (PICOC) criteria originally proposed by Kitchenham (2007) is applied as presented in Table 2.2.

Table 1  
Summary of PICOC

PICOC	Criteria
Population	✓ DNA-based establishment of causation
	✓ DNA laboratory standards
Intervention	DNA Technology
Comparison	Methodologies in Forensic DNA Testing
Outcomes	Presentation of Evidence
Context	Empirical Findings in Academic (Peer Reviews Papers Only)

As shown in Table 1, the PICOC criteria were used as guidelines in developing the research questions in line with the research objectives. As presented in the PICOC, the articles included in this review were consistent with the two research objectives, comprising articles on the DNA-based

establishment of causation and DNA laboratory standards for the presentation of evidence. Hence, the articles were extracted, selected, and analysed while using the research questions as the principal guide in the overall process.

Table 2  
Research Questions for the SLR

Qn. ID	Research Question
SLRQ1	Qn. 1a: To what extent does technology moderate DNA-based establishment of causation in the presentation of evidence?
SLRQ2	Qn. 1b: To what extent does technology moderate DNA laboratory standards in the presentation of evidence?

### Formulation and validation of the review protocol

This review aimed to comprehensively inspect the empirical literature focusing on the technology for DNA presentation. Thereafter, this SLR specifies the search engine, search process, and sources of selection protocol, search process, data extraction strategies, and quality assessment criteria.

### Source selection criteria

In order to select a source for the SLR, the source must meet the following criteria as presented in Table 2.4 below.

### Source selection

The literature search process was performed after the research questions were finalized. Databases and digital libraries were assessed using both search and refining search strings. In order to simplify and widen the range of selected articles, digital databases were searched chronologically according to most popular and familiar.

Table 3  
Digital database library

Seral No	Database	Website link
DB1	EBSCOhost	<a href="http://search.ebscohost.com">http://search.ebscohost.com</a>
DB2	Emeralds	<a href="http://emeraldinsight.com">http://emeraldinsight.com</a> .
DB3	Oxford	<a href="https://academic.oup.com/journals">https://academic.oup.com/journals</a>
DB4	SAGE	<a href="http://journals.sagepub.com">http://journals.sagepub.com</a>
DB5	Science Direct	<a href="http://www.sciencedirect.com/">http://www.sciencedirect.com/</a>
DB6	Scopus	<a href="https://www-scopus-com">https://www-scopus-com</a>

## Study selection procedure

Figure 2.2 depicts the SLR search procedure. The process from the selection using search string created from the list of keywords to actual selection of final papers for analysis is presented. The search string was for created for each database as would help gather relevant papers for analysis. The Boolean operators were used to help retrieve all relevant papers by using “OR” to join the separate keywords, “AND” to join mandatory words that must appear together in any paper, and “NOT” to inform the database about words that are not required as part of the results. The Zotero Browser Plugin automatically imports all results into the reference manager installed on the computer. The results were stored in BibTex file reference formats and imported into Start for analysis. StArt helped filter the papers through the three main stages of identification, selection, extraction and summarization.

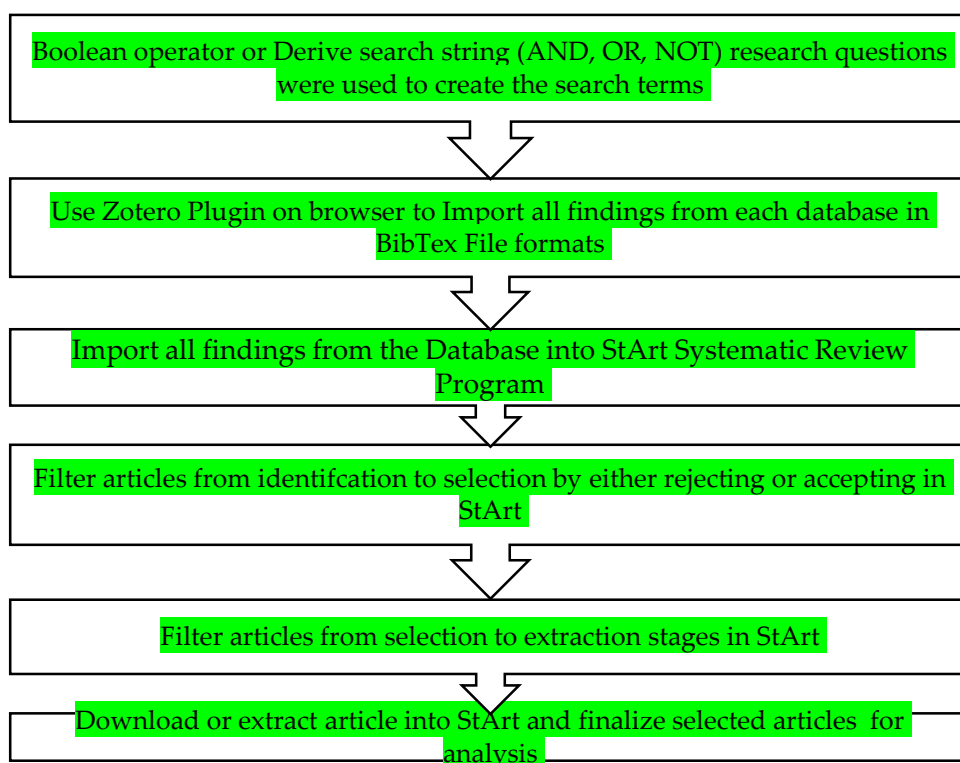


Figure 2. Selection Process

## SLR keywords

In order to create the search string for the databases, specific keywords were used. The keywords were created from the main research questions presented earlier. For the purpose of the present study, each paper must contain at least one set of keywords. In each set, individual words were connected with AND to emphasize the need for, at least, each group of words to be identifiable in any

paper. Where the databases accept the entire keywords list, “OR” was used as a separator of one keyword from the other (Table 4).

Table 4  
Keywords

Qn. ID.	Keywords
SLRQ1	“DNA” AND “Causation” AND “Technology” AND “Evidence”
SLRQ2	“DNA” AND “Laboratory” AND “Standard” AND “Technology” AND “Evidence”

### The EXCLUSION AND INCLUSION CRITERIA AT VARIOUS STAGES of the SLR

Table 5  
Inclusion Criteria

S/N	Criteria	Stage	Description and Example of Cases
1	Only Academic Peer-reviewed	Identification and Selection	Papers peer-reviewed before publishing. These papers undergo strict scrutinization and statistical validation.
2	Conducted between the years 2014 – 2019	Identification	Papers published between 2014 – 2019. A six-year interval is used to gain access to most recent papers and findings
3	Forensic DNA Context	Selection	The study conducted in a Forensic DNA setting
4	Main Variable in an independent position	Extraction	Keyword should be independent of other variables; i.e. it remains unaffected by other variables
5	Keyword/ Variables as a mediator or moderating variable	Selection and Extraction	Variable of interest effects explains the relationship between any of the independent variables on the presentation of evidence.
6	English Language	Identification	Papers were written in English are considered

The Inclusion and Exclusion Criteria are presented in Table 5 and Table 6. Each of these criteria was applied at one of the three stages of identification, selection and extraction. At the search and identification stages, data import considered only peer-reviewed papers as many of the academic databases permit the exclusion of other grey literature and unwanted materials. All the databases also permit the restriction of the search to a unique data range; this helped import only papers published over the last five years, saving time in a highly efficient

manner. Language, grey literature and short papers were also dealt with mainly at the identification stage. At the selection and extraction stages, the papers were inspected to ensure that they met further criteria such as the keyword in an independent position or that the context of the paper is appropriate as required for the SLR. The success of removing papers at the identification stage ensured that the SLR is less time-consuming and conducted in an effective manner.

Table 6  
Exclusion Criteria

S/N	Criteria	Stage	Description and Example of Cases
1	Papers more than 5 years old	Identification	Papers published preceding the year 2012 are excluded from the SLR and considered outdated
2	Secondary and Tertiary Papers	Identification and Selection	Course papers, assignments, and school materials including dissertation and thesis results
3	Short papers	Identification	Article and book reviews; usually 2-4 pages.
4	Non-peer reviewed	Identification and Selection	Conference proceedings and articles that have not gone through peer review evaluation
5	Grey literature	Identification and Selection	Conference proceedings, books, dissertations, theses, dictionaries, and others
5	Duplicated	Identification, selection and extraction	Multiple copies of the same paper are removed from the various stages of identification, selection and extraction.
6	Non-English Written Papers	Identification and Selection	Articles are written in a language other than English, but some abstracts appear in English, but main papers are in other languages – these are excluded
7	Main Variable as a dependent or endogenous variable	Selection and Extraction	Where the variable or population being sought appears out of context – e.g. based establishment of causation appearing as a dependent variable in a paper

### Quality criteria

The quality criteria were very instrumental in rating the papers with regards to the extent to which they meet a high level of quality assurance. Only papers with high-quality assurance above the mid-score of 2.5 are considered in the review analysis. The quality assessment criteria are presented in Table 2.9 below.

Table 7  
Quality assessment criteria

S/N	Criteria	Level of Addressed Criteria					
		Fully Addressed	Partly Addressed				Not Addressed
Score Awarded		5	4	3	2	1	0
QA1	Clearly defined Objective	Objectives of the study clearly identified	Objective partly identified but not clear enough or not blending properly.				Papers with no aim or objectives provided for the study
QA2	Well addressed context	The context of the study is clearly stated.	The context of the study is loosely established.				The context is missing or not clearly defined
QA3	Clearly stated findings	Findings are clearly defined	Findings are ambiguous and not clearly defined				No findings reported
QA4	Good rationale or significance	The practical and theoretical rationale of the study is established.	Some rational and significance is presented but the varied level of adequacy				No significance outlined for practice and theory.
QA5	The uniqueness of Contribution to Academia	In addition to the rationale, strong and unique contributions are made.	Some amount of uniqueness of contribution may be observed in the rationale or significance but not novel.				No form of unique contribution exists or is stated.
QA6	Clearly Defined Limitations	Full limitations of the study are provided	The existence of little or marginal amount of limitations provided.				No forms of limitations are identified

### Data extraction strategy

As a final aspect of the SLR planning, the data extraction strategy is presented in Table 7. The research questions are presented in dedicated search forms. The main item of focus and the descriptions are also presented. The main approach to extracting articles was to identify the main variables or empirical results that pertain to the variables in any selected article. Given that the two research questions were developed to assess a common dependent variable, an article may be linked to the both research questions under a specific context.

Table 8  
Data Extraction

Search Focus	Data item	Description
RQ1	General Result	DNA-based causation proved viable in establishing or presenting forensic evidence
RQ2		DNA laboratory standards impact on the presentation of evidence

### Conducting the review

The section highlights the stages of the review and selection process. The initial aspect focused on the literature search before proceeding to the final selection of articles for further analysis.

### Study identification

Table 2.11 shows the search results from each database, showing the retrieval of 2256 references into StArt program for analysis. DNA and forensic context were used as the keywords to assess the selected and identified articles for eligibility. Hence, DNA testing and authentication articles that were not in line with the research objectives and study context (i.e., witnessing or forensics domain) were not selected for further review. Only studies focusing on the criminal or forensic context were considered for the next analysis.

### Study selection

Of the 2256 articles, 24 of them (1.06%) scaled through the selection stage. The main selection criterion in this phase was the presence of main dependent variable. Other articles that focused on DNA accuracy, testing, and reduction of DNA testing time or rapid DNA analysis, recovery of DNA from the site or maximizing recovery, humanitarian forensic cases, validation of human identification, technological reliability or DNA typing technique, DNA and storage and so on were excluded. The excluded articles also entailed previous studies reporting the use of animals, such as reptiles, fish, dogs and other living samples of trees, logs and soil in establishing genetic, clinical or forensic evidence. All the aforementioned studies were excluded in order to streamline the selected articles and make them relevant and applicable in executing the research objectives.

### Reporting the review

In order to answer the two research questions described in Section 2.1.1, data were extracted from a total of 68 primary articles. The present SLR was prepared according to the guidelines described by Kitchenham.

## The Review Result

### Relevant studies

In order to extract the relevant studies and proceed to the review analysis, some measures were applied; these include, (1) the quality assurance metrics originally presented in Table 8. A total of 24 papers were extracted, and quality assurance metrics awarded. Papers with low quality or quality assurance below 3.0 were excluded from the study. The scores were arrived by awarding each paper a quality criterion of between 1 and 5 across the six areas of quality measurements. A total of 4 papers were excluded at this stage of the analysis, and 20 papers were considered for the main analysis in the next section.

Table 9  
Quality Extraction

Authors	QA1	QA2	Mean Score	Emp-Analysis	Status
Moss (2015)	3	3	3.50	Yes	Accepted
Tuncbag et al., (2016)	4	3	4.17	Yes	Accepted
Marshall et al., (2013)	3	4	4.17	Yes	Accepted
Chakraborty et al., (2015)	2	3	3.67	Yes	Accepted
Wixted et al., (2018)	4	3	3.33	Yes	Accepted
Sheng et al., (2015)	5	4	4.33	Yes	Accepted
Montano et al., (2018)	5	2	3.17	Yes	Accepted
Pickrahn et al., (2017)	1	3	3.33	Yes	Accepted
Benschop et al., (2017)	3	4	4.17	Yes	Accepted
Coble et al., (2016)	4	3	3.17	Yes	Accepted
Cooper et al., (2015)	4	4	3.33	Yes	Accepted
Walsh et al., (2013)	4	3	3.17	Yes	Accepted
Biedermann et al., (2013)	5	2	3.83	Yes	Accepted
Kassin (2013)	3	2	1.83	No	Rejected
Ferreira et al., (2013)	1	3	3.67	Yes	Accepted
Gruijter et al., (2017)	4	2	3.00	Yes	Accepted
Edmond (2013)	3	1	3.67	Yes	Accepted
Ferreira et al.,	3	4	2.83	Yes	Rejected

(2017)					
Kloosterman et al., (2017)	3	3	3.17	Yes	Accepted
Hollard et al., (2017)	5	4	3.33	Yes	Accepted
Baier et al., (2017)	4	3	3.00	Yes	Accepted
Maratkyzy & Dilbarkhanova (2017)	2	2	2.67	No	Rejected
Santos (2014)	3	2	3.00	Yes	Accepted
Palmbach et al., (2014)	2	3	2.5	Yes	Rejected

### **The use of technology to moderate causation in evidence presentation: (RQ1)**

The four included papers pertaining to this research questions are presented in Table 2.15. These include Moss (2015), Sheng et al. (2015), Ferreira et al. (2013) and Edmond (2013). Moss (2015) focused on establishing the necessity for causation in the context of DNA interpretation system. Even though Moss (2015) involved the use of DNA interpretation system, the emphasis was placed on the building of causation with reference to the True Allele for DNA as an interpretation system. Moss (2015) highlighted the need to reduce to minimal level human intervention in DNA witnessing. Furthermore, Moss (2015) cited that forensic testimony does not meet the required standard of causation; the court employed the term “preponderance of the evidence”. In such a case, the evidence was considered not relevant.

Establishing causation is thus considered vital for evidence to be accepted in the law courts. The need to prove causation must, however, be supported with authentic technology systems and not be filled with human assumptions in the presentation of evidence. The removal of human interpretation in the presentation of evidence implies the reducing reliance on expert advice as conclusive to evidence sentence a suspected culprit. Although reliability via technology in establishing causation is pertinent, it is till prone to human connections and psychology of human social contexts. Technology offers several advantages, such as boosting the accuracy of causation findings and the various methodologies used in achieving such results, as well as facilitating consistency of expert advice in the entire process. Moss (2015) acknowledged the paradigm shift in the role of forensic evidence in the presentation of evidence.

In the study conducted by Sheng et al. (2015), the areas of causation and coincidence were covered. Hence, this SLR and the research by Sheng et al. (2015) are the only studies that covered both causation and coincidence, represented by the term “uncertain causation”. In uncertain causation, causation established as a result of coincidence must be considered. Implicitly, causation may occur as a result of coincidence – where coincidence is the main factor governing the established causation. Causation refers to the intrinsic or internal association between factors, whereas removal of coincidence focus on the external

scope of minimizing all likely possibilities of this causation being linked to another event.

Practically, cultural, legal, national, and technological attributes may be possessed by an event that is considered a coincidence. A collection of events may have similarity to existing economic, technological, or social processes known to the case region, and these associations may induce pre-assumptions on the connection between events surrounding the crime. However, Sheng et al. (2015) assert that such connections may not always exist as cited in several cases presented as part of this article. Notably, various countries apply different methods to tackle these issues of coincidence and causation in the law court, and according to Sheng et al. (2015), this discussion are somewhat inseparable.

In the third paper, by using only worn materials of a suspected murderer, a DNA method was successfully employed to link the suspect to the crime scene (Ferreira et al., 2013). This association could not have been established without the help of exiting technology systems. Despite the availability of little evidence in some instances, technology has the capacity to revolutionise linking of evidence to suspects, which is highly commendable. The potential to revolutionise the area of evidence presentation has been demonstrated by new technology on Low Template DNA (L-T DNA) techniques, where evidence are extracted from situations where very little chance exists.

In the final article, Edmond (2013) investigated the case of causation and coincidence in a single case as observed by previous authors (Sheng et al., 2015). Edmond (2013) draws on similar arguments as Sheng et al., (2015) on the role of causation and coincidence in evidence presentation, and the intricate relationship between these two areas. Likewise, knowledge from various fields, including philosophy, history, and sociology were tapped by Edmond (2013). Edmond (2013) study was particularly conducted on the establishment of causation using photo and video interpretations generalised to a defined group of people based on history, philosophy, or sociology. By applying this technology to evidence presentation, clear associations may be drawn on the photo or video evidence.

In Edmond (2013) elaboration, it was established that causation is as a result of leaned associations in psychology and philosophy. Technology can learn and use human abstract relationships and build upon the outcomes in order to establish generalizations. Although such evidence are not highly reliable in evidence presentation, they could be supportive. Given the complexity of forensics, rather than relying obviously on a piece of presented evidence, subjective clues rooted in technology are vital to evidence presentation but need to be cautiously taken into account.

Table 10  
Contexts Details for Papers (RQ1)

Source	Context Details
Moss (2015)	Causation in the context of DNA interpretation system in the presentation of evidence for criminal cases
Sheng et al. (2015)	Regulations, public policy and case law in different countries globally.

Ferreira et al. (2013)	Presenting evidence based on the function of Trace DNA recovered from worn or handled items collected from crime scenes.
Edmond (2013)	The ability of technology to interpret images by building on other fields such as sociology, history, and so on.

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### **The use of technology to moderate laboratory standards in evidence presentation: (RQ2)**

Papers covering the second SLR research question are presented in Table 2.16. Among the five included studies, one study was covered in the earlier SLR research question or Table 2.15 (Moss, 2015). The list of studies here includes Moss (2015), Montano et al. (2018), Benschop et al. (2017), Coble et al. (2016), and Cooper et al. (2015). Moss (2015) as earlier presented, considered the scientific admissibility of doctrines based on the Frye Standard and the Daubert Standard. In the cases presented by Moss (2015), the adoption of different standards in forensics led to unique outcomes in terms of the admissibility of evidence. This leads to critical evidence that the different standards and laboratory processes used to handle evidence have direct implications on the presentation of evidence.

Based on the capabilities of specific technology, including DNA-related methods or True Alle, standards play a pivotal role in the process of considering and weighing evidence in law courts. The paper also considers that judges may not serve as the best gatekeepers of indicating standards of judgements based on forensic technology. There may be the need for expert advice on the processes and laboratory standards used for DNA witnessing, and these experts must brief the jury or judges on the chances of technology failure and to what extent these chances may occur. Standards may as well be very instrumental in proving the reliability of evidence in the law court. In the second study supporting the moderating role of technology in laboratory standards, Montano et al., (2018) elaborate on the case of the standard protocol employed for assurance in forensic laboratories. Standardization does not only ensure quality assurance but as well leads to quality measures, efficiency gains, the possibility of automation, among other benefits through consistency and standardised processing using technology. The standardisation of technology used in the laboratory ensures that the same standards are implemented across cases in the presentation of evidence. This ensures a high level of consistency, structural, replicability of evidence presentation.

Benschop et al. (2017), on the other hand, considered standardisation in of forensic practice at the laboratory level as well as the standardization in forensic methodologies as different across laboratories. Benschop et al. (2017) emphasised on the need to improve laboratory guidelines to ensure consistency. Technology standardisation may form a part of the larger need for standardisation of laboratory methods and forensic practice. This assertion was similar to that of Montano et al., (2018) who considered standardization in the area of technology. Coble et al., (2016) considered standardisation in reporting standards in which quality measures were invoked, with direct implications to the reporting of evidence. In their discussion, they elaborated on the role of standards in software

validation, verification and test documentation (Yahya et al. (2014) and Moketar et al (2016) . As part of their recommendation, they emphasised the need for internally developed standards based on internal validation data. The last paper in this domain considered the standardization in DNA profile interpretation across different jurisdictions (Cooper et al., 2015). Technology systems in this area are therefore encouraged to employ continues models by helping achieve the same answer regardless of where or what system is employed.

Table 11  
Context Details for Papers (RQ2)

Source	Context Details
Montano et al., (2018)	standard protocol in forensic laboratories
Moss (2015)	Scientific admissibility of doctrines based on the Frye Standard and the Daubert Standard
Benschop et al. (2017)	Standardisation of practice at the laboratory levels
Coble et al. (2016)	Standardisation in reporting standards in which quality measures were invoked
Cooper et al. (2015)	Standardisation in DNA profile interpretation of technology

Laboratory standards have been observed as one of the key factors that determine the authenticity of evidence presented in the law court (Montano et al., 2018; Moss, 2015; Benschop et al., 2017; Coble et al., 2016; Cooper et al., 2015). Laboratory standards have been established as one of the critical aspects of objective, replicable, and authentic evidence presentation in the analysis of forensic evidence (Cooper et al., 2015). 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 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 Moss (2015) 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.

Montano et al., (2018) 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 Montano et al., (2018), 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 Benschop et al., (2017) in all areas of case management including reporting (Coble et al., 2016) and interpretation methods (Cooper et al., 2015).

## **Conclusion**

This paper focused on establishing causation and supporting laboratory standards for presentation of evidence. As a summary, this paper discussed on how causation and laboratory standards are moderated through the use of technology for presentation. Based on author findings, there are four key reasons how establishing causation impact of evidence presentation. The first relates to the criminal cases where evidence are presented based on the perspective of DNA interpretation system. The second includes public policies, regulations, and case law in different countries worldwide. Next is presenting evidence based on the role of Trace DNA recovered from worn or handled items retrieved from crime scenes. The final feature is the extent in which technology can successfully interpret images while incorporating other related fields, such as history and sociology.

Meanwhile the author also found the contexts of how laboratory standards are moderated through the use of technology give impact to the evidence presentation. There 5 standardization contexts are focused. First is standard protocol in forensic laboratories. Second is Scientific admissibility of doctrines based on the Frye Standard and the Daubert Standard. Third is Standardisation of practice at the laboratory levels. Fourth is Standardisation in reporting standards in which quality measures were invoked and lastly is the Standardisation in DNA profile interpretation of technology. Future research will entail a survey among users in the forensic industry, specifically, to assess the levels of technology use and usage pattern, as well as the influencing factors of evidence presentation. A quantitative research method will be applied for the data analysis to determine the predictors of the degree of evidence presentation.

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## **References**

Al Darmaki, A. R. (2016). A Systematic Analysis Of Strategic Planning Key Success Factors And Its Required Professional Skills-Case Study Of Abu Dhabi Police Ghq. *International Journal of Sales, Retailing & Marketing*, 5(4).

- Alamoudi, E., Mehmood, R., Albeshri, A., & Gojobori, T. (2017, November). DNA profiling methods and tools: a review. In *International Conference on Smart Cities, Infrastructure, Technologies and Applications* (pp. 216-231). Springer, Cham.
- Ali MH, Jaber MM, Abd SK, Rehman A, Awan MJ, Vitkutė-Adžgauskienė D, Damaševičius R, Bahaj SA. Harris Hawks Sparse Auto-Encoder Networks for Automatic Speech Recognition System. *Applied Sciences*. 2022; 12(3):1091. <https://doi.org/10.3390/app12031091>
- Amir, S. (2019). UAE forensic unit tackles chlorine leak and fatal child poisoning to see justice done. Available at: <https://www.thenational.ae/uae/uae-forensic-unit-tackles-chlorine-leak-and-fatal-child-poisoning-to-see-justice-done-1.958053> [Accessed: January 20, 2019]
- Baier, W., Norman, D. G., Warnett, J. M., Payne, M., Harrison, N. P., Hunt, N. C., ... & Williams, M. A. (2017). Novel application of three-dimensional technologies in a case of dismemberment. *Forensic science international*, 270, 139-145.
- Bakhtiari, M., Shleizer-Burko, S., Gymrek, M., Bansal, V., & Bafna, V. (2018). Targeted genotyping of variable number tandem repeats with adVNTR. *Genome research*, 28(11), 1709-1719.
- Benschop, C. C., Connolly, E., Ansell, R., & Kokshoorn, B. (2017). Results of an inter and intra laboratory exercise on the assessment of complex autosomal DNA profiles. *Science & Justice*, 57(1), 21-27.
- Biedermann, A., Hicks, T., Voisard, R., Taroni, F., Champod, C., Aitken, C. G. G., & Evett, I. W. (2013). E-learning initiatives in forensic interpretation: report on experiences from current projects and outlook. *Forensic science international*, 230(1-3), 2-7.
- Blaxter, L. (2010). *How to research*. McGraw-Hill Education (UK).
- De Gruijter, M., Nee, C., & De Poot, C. J. (2017). Identification at the crime scene: The sooner, the better? The interpretation of rapid identification information by CSIs at the crime scene. *Science & justice*, 57(4), 296-306.
- Edmond, G. (2013). Just truth? Carefully applying history, philosophy and sociology of science to the forensic use of CCTV images. *Studies in history and philosophy of science part C: studies in history and philosophy of biological and biomedical sciences*, 44(1), 80-91.
- Ghufli, A. H. B. (2014). *Training needs analysis: an empirical study of the Abu Dhabi Police* (Doctoral dissertation). Brunel University London.
- Gill, P. (2018). DNA evidence and miscarriages of justice. *Forensic science international*, 294, e1-e3.
- Gottfredson, M. R. (2017). In pursuit of a general theory of crime. *The Origins of American Criminology: Advances in Criminological Theory*, 333.
- Grix, J. (2010). *The foundations of research*. Palgrave Macmillan.
- Hoelz, B. W., Ralha, C. G., & Geeverghese, R. (2009). Artificial intelligence applied to computer forensics. In: *Proceedings of the 2009 ACM symposium on Applied Computing* (pp. 883-888). ACM.
- Hollard, C., Keyser, C., Delabarde, T., Gonzalez, A., Lamego, C. V., Zvěnigorosky, V., & Ludes, B. (2017). Case report: on the use of the HID-Ion AmpliSeq™ Ancestry Panel in a real forensic case. *International journal of legal medicine*, 131(2), 351-358.
- Holtzman NA, Murphy PD, Watson MS, Barr PA (1997). Predictive genetic testing: from basic research to clinical practice. *Science*. 278 (5338): 602-5.

- Horvath, F., Meesig, R. & Y. Lee. (2001) A national survey of police policies and practices regarding the criminal investigation process: twenty-five years after Rand. East Lansing, MI: Michigan State University Press.
- House of Commons Science and Technology Committee (2005). Forensic Science on trial, UK: House of Commons Science and Technology Committee.
- Howes, L. M. (2015). The communication of forensic science in the criminal justice system: A review of theory and proposed directions for research. *Science & Justice*, 55(2), 145-154.
- Jaber M.M., Abd S.K., Ali S.M. (2022) Adam Optimized Deep Learning Model for Segmenting ROI Region in Medical Imaging. In: Al-Emran M., Al-Sharafi M.A., Al-Kabi M.N., Shaalan K. (eds) Proceedings of International Conference on Emerging Technologies and Intelligent Systems. ICETIS 2021. Lecture Notes in Networks and Systems, vol 322. Springer, Cham. [https://doi.org/10.1007/978-3-030-85990-9\\_54](https://doi.org/10.1007/978-3-030-85990-9_54)
- Jaber, M. M., Abd, S. K., Shakeel, P. M., Burhanuddin, M. A., Mohammed, M. A., & Yussof, S. (2020). A telemedicine tool framework for lung sounds classification using ensemble classifier algorithms. *Measurement: Journal of the International Measurement Confederation*, 162, 107883. <https://doi.org/10.1016/j.measurement.2020.107883>
- Kiely, T. F. (2005). Science and the Criminal Law. In *Forensic Evidence* (pp. 19-58). CRC Press.
- Kitchenham, B. A. (2007). *Guidelines for Performing Systematic Literature Reviews in Software Engineering*.
- Kloosterman, A., Mapes, A., Geradts, Z., van Eijk, E., Koper, C., van den Berg, J., ... & van Asten, A. (2015). The interface between forensic science and technology: How technology could cause a paradigm shift in the role of forensic institutes in the criminal justice system. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 370(1674).
- Machado, H., & Granja, R. (2020). DNA Technologies in Criminal Investigation and Courts. In *Forensic Genetics in the Governance of Crime* (pp. 45-56). Palgrave Pivot, Singapore.
- Maratkyzy, A. & Dilbarkhanova, Z. R. (2017). Preliminary Study on Biological Traces on the Crime Scene. *Journal of Advanced Research in Law and Economics*. Fall, 5(27), 1556-1562.
- Moketar.NA, Kamalrudin.M, Sidek.M, Robinson.M and Grundy.J, "TestMEREQ: Generating Abstract Tests for Requirements Validation," 2016 IEEE/ACM 3rd International Workshop on Software Engineering Research and Industrial Practice (SER&IP), 2016, pp. 39-45.
- Morgan, R. M. (2017). Conceptualising forensic science and forensic reconstruction. Part II: The critical interaction between research, policy/law and practice. *Science & Justice*, 57(6), 460-467.
- Mortera, J. (2019). DNA Mixtures in Forensic Investigations: The Statistical State of the Art. *Annual Review of Statistics and Its Application*, 7.
- Moss, K. L. (2015). The Admissibility of True Allele: A Computerized DNA Interpretation System. *Wash. & Lee L. Rev.*, 72, 1033.
- Murphy, E. (2018). Forensic DNA typing. *Annual Review of Criminology*, 1, 497-515.
- Ponizovskiy, M. R. (2017). Biophysical and biochemical mechanisms of forming and development a human eukaryotic organism from single pluripotent cell

- into multicellular embryo and a living organism in norm. *Journal of Genetics and DNA research*, 1(1), 1-12.
- Prieto, L., Gill, P., & Bleka, Ø. (2019). How to avoid driving DNA caseworkers crazy: CaseSolver, an expert system to investigate complex crime scenes. *Forensic Science International: Genetics Supplement Series*.
- Rodrigues, C. V., & Toledo, J. C. D. (2017). A value-based method for measuring performance on Forensic Science service. *Gestão & Produção*, 24(3), 538-556.
- Rt, H. (2015). The legal framework for more robust forensic science evidence. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 370(1674).
- Rughani, P. H. (2017). Artificial Intelligence Based Digital Forensics Framework. *International Journal*, 8(8).
- Saks, M. J., & Koehler, J. J. (2005). The coming paradigm shift in forensic identification science. *Science*, 309(5736), 892-895.
- Sallavaci, O. (2014). The impact of scientific evidence on the criminal trial: the case of DNA evidence. Routledge.
- Santos, F. (2014). Making sense of the story—the dialogues between the police and forensic laboratories in the construction of DNA evidence. *New Genetics and Society*, 33(2), 181-203.
- Sharma, P. N., & Kim, K. H. (2013). A comparison of PLS and ML bootstrapping techniques in SEM: A Monte Carlo study. In *New perspectives in partial least squares and related methods* (pp. 201-208). Springer, New York, NY.
- Sheng, H. X., Ricci, P. F., & Fang, Q. (2015). Legally binding precautionary and prevention principles: Aspects of epistemic uncertain causation. *Environmental Science & Policy*, 54, 185-198.
- Syazwani, Y, Kamalrudin.M and Sidek.S and Grundy.J, (2014). Capturing Security Requirements Using Essential Use Cases (EUCs). *Communications in Computer and Information Science*. 432. 16-30. 10.1007/978-3-662-43610-3\_2.
- Syazwani, Y, Kamalrudin.M and Sidek.S, "A review on tool supports for security requirements engineering," 2013 IEEE Conference on Open Systems (ICOS), 2013, pp. 190-194, doi: 10.1109/ICOS.2013.6735072.
- The National (2014). Abu Dhabi Police forensics cracked 1,286 cases last year. Retrieved from: <https://www.thenational.ae/uae/abu-dhabi-police-forensics-cracked-1-286-cases-last-year-1.306700>
- Thompson, W. C. (1996). DNA evidence in the OJ Simpson trial. *U. Colo. L. Rev.*, 67, 827.
- Wilson, D. B., Weisburd, D., McClure, D., & Wilson, D. B. (2011). Use of DNA testing in police investigative work for increasing offender. *Campbell Systematic Reviews*, 7.
- Wixted, J. T., Christenfeld, N. J., & Rouder, J. N. (2018). A Bayesian statistical analysis of the DNA contamination scenario. *Jurimetrics*, 58, 211-242.
- Wright, B. R. E., Caspi, A., Moffitt, T. E., & Silva, P. A. (2001). The effects of social ties on crime vary by criminal propensity: A life-course model of interdependence. *Criminology*, 39(2), 321-348.