



**Institute of Technology Management and Entrepreneurship**



**THE ROLE OF ARTIFICIAL INTELLIGENCE MODEL IN  
FORENSIC DNA METHODS TOWARDS EVIDENCE  
PRESENTATION IN UAE**

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**THE ROLE OF ARTIFICIAL INTELLIGENCE MODEL IN FORENSIC DNA  
METHODS TOWARDS EVIDENCE PRESENTATION IN UAE**

**Wafa Altayari**

**A thesis submitted  
in fulfilment of the requirements for the degree of Doctor of Philosophy**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2022**

## DECLARATION

I declare that this thesis entitled “The Role of Artificial Intelligence Model in Forensic DNA Methods Towards Evidence Presentation In UAE” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

 Signature :   
Supervisor Name : Prof Ts Dr Massila Kamalrudin  
Date : 12/4/2022

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## DEDICATION

“To research means to see what all people have seen and to think what nobody has  
thought”

Dedicated to my Beloved Family Specially my Spouse Ali.



## ABSTRACT

Forensic science, particularly the authenticity of its role in the presentation of evidence in the law courts is at a critical juncture. Several challenges and solutions have been observed in this area, and this continues to evolve consistent with the increasing role of AI DNA technology in evidence presentation. Addition to this, even though significant advancements have been made in the forensic innovation since its original introduction, evidence on whether technology has enhanced the success and presentation of evidence is still insignificant. The main objectives of the study are firstly, to analyse the scopes of artificial intelligence DNA technology necessary to improve the forensic evidence presentation. Second, is to develop new artificial intelligence model to be used in DNA witnessing step which should improve the evidence presentation over traditional methods and thirdly, to validate the developed model of artificial intelligence technology by assessing the improvement in aligning DNA methods with evidence presentation. The scope of this study is focussing on the investigation at the two leading forensic DNA labs in UAE; 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. For the methods, a predominantly quantitative research methodology was considered with the support of an experiment to observe the developed artificial intelligence model in DNA witnessing over traditional methods. Beside the Structural Equation Model (SEM) approach had been used to test the introduced model. The results show that: first, the existing technology do not moderate causation, laboratory standards, interpretation, and removal of coincidences in the presentation of evidence. This was observed even though the individual antecedents do contribute to the presentation of evidence. Second, it was found that technology is a significant predictor of the presentation of evidence. Finally, the experimentation revealed that the developed intelligent system has significant reach beyond current technology capabilities and remains instrumental to the presentation of evidence. It is concluded that existing technology may not have the capacity to moderate the contribution of causation laboratory standards, interpretation and removal of coincidences in the presentation of evidence. Feats, like the experimental intelligent system, must be pursued to ensure that technology plays an important role in DNA witnessing, to help improve the overall objectivity and authenticity of the witnessing process.

**Key Words:** Forensic, DNA, AI Technology, Evidence Presentation.

# **PERANAN TEKNOLOGI DALAM KAEDAH BERASASKAN DNA KE ARAH PENYAMPAIAN BUKTI FORENSIK**

## **ABSTRAK**

Sains forensik terutamanya dari sudut kepentingan peranannya dalam penyampaian bukti di mahkamah undang-undang menjadikan ianya bidang kritikal. Perkembangan ini seiring dengan meningkatnya peranan teknologi AI dalam penyampaian bukti. *Penyataan masalah kajian:* Walaupun ada kemajuan yang signifikan dalam pelaksanaan inovasi forensik sejak awal kemunculannya, kajian mengenai sama ada teknologi telah meningkatkan kejayaan dalam penyampaian bukti masih lagi sedikit. *Objektif utama kajian ini adalah:* Pertama, untuk menganalisis ruang lingkup teknologi kecerdasan buatan DNA yang diperlukan untuk meningkatkan penyampaian bukti forensik. Kedua, untuk membangunkan model kecerdasan buatan baru yang akan digunakan dalam langkah penyaksian DNA yang boleh meningkatkan penyampaian bukti berbanding kaedah tradisional. Ketiga, untuk mengesahkan model teknologi kecerdasan buatan yang dibangunkan dengan menilai peningkatan dalam menyelaraskan kaedah DNA dengan penyampaian bukti. *Skop:* Penyelidikan ini memberi tumpuan kepada makmal DNA di UAE. Secara khusus, dua makmal DNA forensik terkemuka dipertimbangkan dalam penyelidikan ini; Makmal Forensik Biologi Jabatan Forensik Pembuktian di Pejabat Polis Abu Dhabi dan Makmal Forensik di bawah Jabatan Am Ibu Pejabat Forensik Sains dan Kriminologi yang ditubuhkan oleh Polis Dubai. Bagi kaedah penyelidikan, langkah penyelidikan kuantitatif menjadi sebahagian besar metodologi yang dipertimbangkan. Eksperimen turut dilaksanakan sebagai sokongan untuk mengamati model kecerdasan buatan penyaksian DNA yang dibangunkan berbanding kaedah tradisional. Di samping itu, pendekatan Structural Equation Model (SEM) telah digunakan untuk menguji model yang diperkenalkan. *Penemuan utama dan Perbincangan:* Hasil menunjukkan bahawa: pertama, teknologi sediaada tidak menyederhanakan tuduhan, standard makmal, tafsiran dan penghapusan kebetulan dalam penyampaian bukti. Ini diperhatikan walaupun setiap atecceden individu menyumbang kepada presentasi bukti. Kedua, didapati bahawa teknologi merupakan peramal utama penyampaian bukti. Akhirnya, Siri eksperimen menunjukkan bahawa sistem pintar baru mempunyai jangkauan yang signifikan melebihi kemampuan teknologi semasa dan tetap berperanan dalam penyampaian bukti. Sebagai konklusinya, dapat disimpulkan bahawa teknologi sediaada tidak memiliki kemampuan untuk menyederhanakan tuduhan, standard makmal, penafsiran dan penghapusan kebetulan dalam penyampaian bukti. Sebagai tambahan, seperti sistem pintar eksperimen, mesti dilaksanakan untuk memastikan bahawa teknologi memainkan peranan penting dalam penyaksian DNA, untuk membantu meningkatkan objektif dan kesahihan keseluruhan proses penyaksian.

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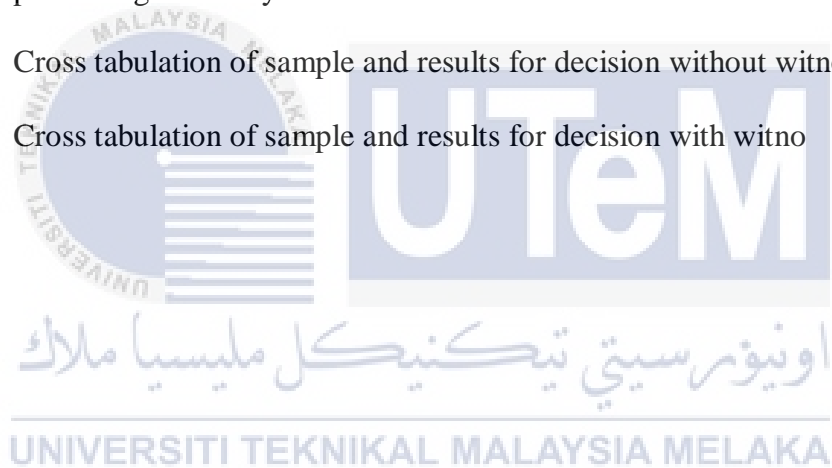


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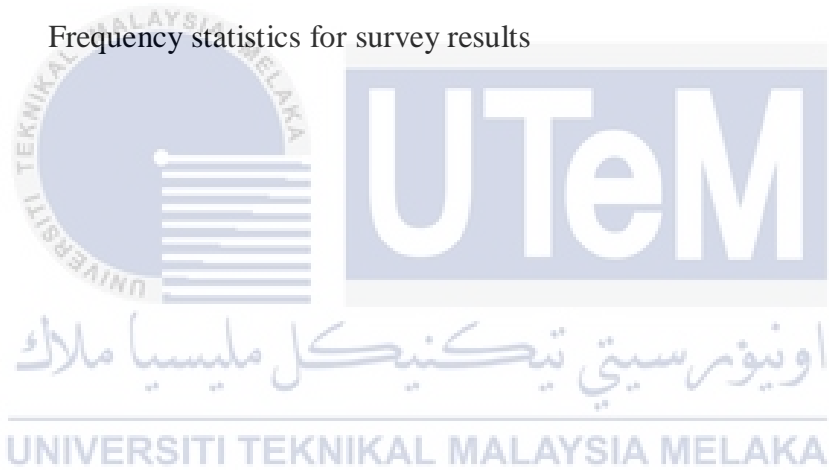
CFA	-	Confirmatory Factor Analysis
DNA	-	Deoxyribonucleic Acid
EFA	-	Exploratory Factor Analysis
GCC	-	Gulf Corporation Council
PICOC	-	Population, Intervention, Comparison Outcomes and Context
RNA	-	Ribonucleic acid
SLR	-	Systematic Literature Review
UAE	-	United Arab Emirates
AI	-	Artificial Intelligence

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## LIST OF PUBLICATIONS

### Journal with impact factor

1. Altayari, W., and Kamalrudin, M., 2020. The Role of Technology in Forensic Evidence Presentation: Conceptual Framework. *Medico-Legal Update* (Peer Review).
2. Altayari, W., and Kamalrudin, M., 2020. The Use of Technology to Moderate Causation and Laboratory Standards in Evidence Presentation: A Systematic Review. *Medico-Legal Update* (Peer Review).
3. Altayari, W., and Kamalrudin, M., 2018. The Role of DNA Based- Methods in the Presentation of Forensic Evidence: A Systematic Literature Review. *The Turkish Online Journal of Design, Art and Communication (TOJDAC)*, pp. 2590-2598.

### Conference proceeding

- Altayari, W., and Kamalrudin, M. (2018). The Role of DNA Based- Methods in the Presentation of Forensic Evidence: A Systematic Literature Review. ISoRIS 2018.
- Altayari, W. (2018). Current Status of Laboratories Carrying Out DNA Analysis in Arab Forensic Laboratories: Workshop. 4th International Conference of Forensic Science in Saudi Arabia (27th-29th of November, 2018).

## CHAPTER 1

### INTRODUCTION

This chapter introduces the background on the topics of this thesis that centers on the facilitating role of artificial intelligence DNA technology in DNA-based methods towards the presentation of forensic evidence in the UAE. Among the topics introduced are the problem statement, research questions, objectives, scopes, and significances. Definition of terms are described in this chapter. The thesis organization is presented at the end of this chapter.

#### 1.1 Background of forensic science

Forensic science, particularly the authenticity of its role in the presentation of evidence in the law courts is at a critical juncture (O'Brien et al., 2015). A number of pitfalls, challenges and solutions have been observed in this arena, and this continues to evolve consistent with the increasing role of technology in evidence presentation (Santos, 2014). Recognizing the heightened role of modern technology in forensic investigations, Kloosterman et al. (2015) 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).

According to Baier et al. (2017), technology plays an important role in the visualisation and the presentation of evidence in the law court. 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. Nonetheless, as mentioned by Ribaux and Wright (2014):

“Whatever the level of sophistication of procedures and models for making decisions, forensic failures will continue to occur unavoidably. Each high-profile case will invariably put a little more pressure on the system with the effect of progressively confining scientific laboratories in the landscape of the justice system.”

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 (Nieman, 2009; National Research Council, 2011; Roberts, 2015). 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 (Roberts, 2015).

Ultimately, the urgent need for attention in this area is based on the premise that criminal adjudication is not an area worth compromising. It has, therefore, remained imperative to resolve the shortcomings of forensic science and other expert advice (Roberts, 2015). Wherever forensic evidence appears, it is essential that the evidence has a scientific foundation, expert opinion is appropriately understood, and the establishment of causation is clearly explained (Rt, 2015). Sound forensic science is critical to the conviction of the guilty and the acquittal of the innocent. The changes and emphasis on the need for excellent

and comprehensive report necessary for criminal proceedings and reliability are, therefore, a necessary evolution (House of Commons Science and Technology Committee, 2005).

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 and 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 by Kloosterman et al. (2015) to arrive at novel methods that can be seamlessly applied in the criminal justice system which emphasise:

“Only through technology can such requirements [guaranteeing the quality of forensic findings] be met, and efforts should be aimed at automated forensic interpretation, reporting uncertainties and minimising potential errors by the operators.”

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. The present study employs a quantitative research methodology and a forensic experiment

of a newly patented forensic technology to assess the overall effect of causation, laboratory standards, interpretation, and removal of coincidence on the presentation of evidence.

## **1.2 Background of forensic evidence presentation in the United Arab Emirates**

The United Arab Emirates (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. For this reason, all the Emirates have individual forensic laboratories to handle different criminal cases that are brought to their attention. 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 (Abdullah, 2019; Amir, 2019). 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 Abdullah (2019), forensic laboratories also provide the police with continuous development through the use of advanced and environment-friendly equipment. These systems ensure quick and accurate analysis of forensic evidence to make it ready for presentation. The laboratories also provide technical reports to competent authorities such at the local and federal levels. Key clients also exist at the international and local communities; the forensic laboratories of the UAE are often called to present scientific research and other presentation at international and local forums.

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 (Abdullah, 2019; Amir, 2019). The forensic units, therefore, play an important role