Online ISSN: 2588-3526

Journal of Wildlife and Biodiversity

Volume 9(2): 77-94 (2025) (http://www.wildlife-biodiversity.com/)

Research Article

The role of forensic DNA experts and Artificial Intelligence in enhancing the effectiveness of wildlife crime investigations in Cyprus

Salam Hassan[1], Ahmad Ali*[1], Kawar Mohammed Mousa[2]

[1]Department of Public law, Near East University, Nicosia 99138, North Cyprus, via Mersin 10, Turkey
[2]Department of Business Administration, Near East University, Nicosia 99138, North Cyprus, via Mersin 10, Turkey
*Email: ahmed.ali@neu.edu.tr

Received: 03 January 2025 / Revised: 23 February 2025 / Accepted: 25 February 2025/ Published online: 26 February 2025.
How to cite: Hasan, S., Ali, A., Mousa, K.M. (2025). The role of forensic DNA experts and Artificial Intelligence in enhancing the effectiveness of wildlife crime investigations in Cyprus, Journal of Wildlife and Biodiversity, 9(2), 77-94. DOI: https://doi.org/10.5281/zenodo.15510998

Abstract

The increasing prevalence of wildlife crimes globally and in Cyprus presents an urgent need for more effective investigation methods. This study explores the factors that influence the effectiveness of wildlife crime investigations, focusing on the role of forensic DNA experts, different forensic methods, inter-agency relationships, and the incorporation of Artificial Intelligence (AI)-based tools. Employing a quantitative approach and a sample of 560 respondents, the study finds that all the posited variables involvement of forensic DNA experts, types of forensic methods used, organizational and operational relationships, and AI-based forensic tools significantly influence the outcome of investigations. Forensic DNA experts and AI-based forensic tools are key contributors to investigation success. These findings show that forensic DNA experts ($\beta = 0.60$), modern forensic methods ($\beta = 0.30$), inter-agency relationships ($\beta = 0.20$), and AI-based tools ($\beta = 0.40$) significantly enhance wildlife crime investigations, highlighting the need for specialized training, advanced forensic techniques, and AI integration. The study fills an existing gap in research by focusing on Cyprus, an area underrepresented in previous studies. It also introduces AI-based tools such as machine learning algorithms for pattern recognition, automated DNA analysis, facial and species recognition software, and predictive analytics as a novel factor in enhancing the effectiveness of wildlife crime investigations.

Keywords: Wildlife Crime, Law Enforcement, Forensic, AI.

Introduction

Wildlife crime is a major global concern with ecological and economic ramifications (Haq et al., 2023; Massé et al., 2021). The illegal wildlife trade is estimated to be worth $7 to $23 billion a year, according to a report by the United Nations Office on Drugs and Crime (UNODC) (UNODC, 2016). Furthermore, the World Wildlife Fund claims that vertebrate species populations have declined by an average of 60% during the 1970s. Through the spread of zoonotic illnesses, these crimes have endangered species and had far-reaching consequences for biodiversity, ecological balance, and global health (Antony, 2018; Silva-Ramos et al., 2023; Wegner et al., 2022). As a result, countries around the world are taking a multi-pronged strategy to combat this issue, including law enforcement, community involvement, and scientific research.

While the situation in Cyprus is not as dire as it is in other areas of the world, it is far from insignificant. Because of its unusual geographical location and different ecosystems, the island nation has been dealing with wildlife crimes, including poaching and illegal trading of indigenous animals. While specific figures are difficult to come by, past research has shown a steady increase in wildlife-related events over the last decade Cyprus Wildlife Research Institute, 2020. Cyprus's natural heritage and biodiversity are increasingly under threat, necessitating fast and novel intervention techniques to effectively combat wildlife crime (Haq et al., 2023; Iordăchescu et al., 2023; Krämer, 2019; Massé et al., 2021; Federica Panzarella, 2020; Wegner et al., 2022).

For a variety of reasons, the success of wildlife crime investigations is critical. Successful investigations not only bring wrongdoers to justice, but they also serve as deterrents to future criminals (Lavorgna & Sajeva, 2021; Meeks, 2006). Previous research has underlined the need to resolve wildlife crimes in a fast and correct manner to safeguard endangered species (Haq et al., 2023; Iordăchescu et al., 2023; Krämer, 2019; Massé et al., 2021; Federica Panzarella, 2020; Wegner et al., 2022). Furthermore, the impact of effective investigations has been observed to extend to broader issues such as national security, public health, and economic stability (Haq et al., 2023; Iordăchescu et al., 2023; Krämer, 2019; Massé et al., 2021; Federica Panzarella, 2020; Wegner et al., 2022). Poor investigative tactics, for example, have been demonstrated to contribute to the perpetuation of illegal wildlife trading networks, with serious consequences for world health due to the spread of zoonotic diseases (Haq et al., 2023; Iordăchescu et al., 2023; Krämer, 2019; Massé et al., 2021; Federica Panzarella, 2020; Wegner et al., 2022). As a result, understanding and increasing the success of these investigations has both immediate and long-term implications.

While the importance of effective investigations is broadly accepted, various obstacles impede this important. The lack of specialized knowledge in the investigating teams is the most serious of them (Hadjigeorgiou & Kapardis, 2023). Conventional forensic tools are frequently insufficient in dealing with the intricacies of wildlife crimes (Gouda et al., 2020; Grojek & Sikos, 2022; Mayer, 2019; Richards et al., 2021). Inconsistent coordination among the various government departments participating in investigations aggravates the problem, resulting in delays and inefficiencies (Hadjigeorgiou & Kapardis, 2023). Furthermore, legal flaws and a lack of severe consequences contribute to the ineffectiveness of investigations and subsequent prosecutions (Silva-Ramos et al., 2023). In addition, there is a noticeable lag in combining technology breakthroughs such as AI into conventional forensic methodologies, which impedes the speedy and correct resolution of cases (Oosthuizen et al., 2023). These combined problems make it vital to critically analyse and enhance the effectiveness of wildlife crime investigations, particularly in a country like Cyprus, which is still establishing its capacities in this area.

Several concerns with investigative efficacy have been well-documented in earlier studies. According to (Thomas et al., 2023) standard forensic methodologies used in investigations frequently produce equivocal or useless conclusions. Similarly, (Anagnostou et al., 2020) emphasizes that detectives are frequently under-trained to cope with the special obstacles given by wildlife crimes, resulting in unproductive or inconclusive investigations. (Dunlop & Gassman-Pines, 2021) describes the issues that arise from a lack of inter-agency cooperation, which frequently results in missed leads, ineffective information sharing, and inefficient resource utilization. (Anagnostou, 2021) contends that even when an inquiry is thorough, legal flaws and obstacles in international law make it impossible to hold perpetrators accountable. These studies highlight to a significant need for rethinking how the success of investigations is assessed and improved.

While past research has mostly focused on the shortcomings of traditional methodologies or the human aspect in investigations, this research takes a fresh approach by incorporating Forensic DNA Experts and AI algorithms into the investigative process. In terms of methodology, this study applies Structural Equation Modeling (SEM) via the SMART PLS software, whereas most earlier investigations relied on qualitative methods or simple statistical analysis. This study's conceptual framework goes beyond the conventional legal and human factors to include technology and scientific dimensions.

Unlike prior research models, which mostly focused on law enforcement perspectives, our study takes a multi-disciplinary approach, tying together forensic science, artificial intelligence, and criminal law to provide a comprehensive knowledge of wildlife crime investigations. This study intends to not only identify the elements influencing investigation efficacy, but also to provide actual evidence of the value offered by Forensic DNA Experts and AI, thus filling a vacuum in the literature (Veldhuis et al., 2022).

Preliminary findings show a strong relationship between the engagement of Forensic DNA Experts, the employment of AI algorithms, and the success of wildlife crime investigations. These findings corroborate (Oosthuizen et al., 2023) claims about the potential of AI in boosting forensic analyses. The study adds to existing knowledge by offering empirical data that can help officials revise their approach for investigating wildlife crime. It has practical implications for how resources might be more efficiently utilized, such as focusing on specialized training for forensic DNA professionals and incorporating AI-based analysis tools into investigative methods. The study benefits not only law enforcement but also ecological preservation by providing a framework for more effective investigations, with broad societal ramifications.

The rest of this paper is structured as follows: Section 2 will give an in-depth analysis of the relevant literature, with an emphasis on the gaps that this study will fill. Section 3 will provide an overview of the approach, including SEM analysis and data collection procedures. Section 4 will describe the findings and explore their ramifications both locally (in Cyprus) and globally. Section 5 will go over the policy recommendations based on the research findings. Finally, Section 6 will present the study's results, limitations, and recommendations for further research (Smith, 2018).

Investigational Effectiveness

The "Effectiveness of Investigations" has received a lot of attention in criminology and environmental studies. (Thomas et al., 2023) raised the topic first, stating that the inefficiency of investigations substantially limits law enforcement's ability to deal with the increasing prevalence of wildlife offenses. (Anagnostou et al., 2020) investigated the technical flaws, highlighting that most wildlife investigations lack suitable forensic methodologies and hence fail to offer useful findings. (Dunlop & Gassman-Pines, 2021) expanded on the systemic difficulties, noting that inadequate coordination across various government departments frequently results in lengthy and unproductive investigations. (Anagnostou, 2021) went on to investigate the legal issues, stating that even when investigations are properly conducted, criminals are still likely to escape justice

due to legal loopholes or a lack of international collaboration. These studies show that the effectiveness of wildlife crime investigations is complicated, making it a compelling dependent variable for this study.

Understanding the success of investigations is critical since it is the foundation for larger conservation and criminal justice aims. (Thomas et al., 2023) discovered that effective investigations not only bring justice in particular cases, but also serve as a strong deterrent to future offences. (Anagnostou et al., 2020) linked inadequate investigations to an increase in zoonotic illnesses, which has significant public health concerns. Poor investigations, according to (Dunlop & Gassman-Pines, 2021) could lead to the disintegration of international cooperation in wildlife preservation initiatives. (Williams, 2019) emphasized that unsuccessful investigations have financial consequences; a rise in wildlife crimes can have a considerable impact on tourism, which is a major economic source for many countries. Given the wide-ranging effects on public health, the economy, international relations, and biodiversity, the effectiveness of investigations must be addressed.

Investigational Effectiveness

Involvement of Forensic DNA Experts

The "Effectiveness of Investigations" has received a lot of attention in criminology and environmental studies. (Thomas et al., 2023) raised the topic first, stating that the inefficiency of investigations substantially limits law enforcement's ability to deal with the increasing prevalence of wildlife offences. (Anagnostou et al., 2020) investigated the technical flaws, highlighting that most wildlife investigations lack suitable forensic methodologies and hence fail to offer useful findings. (Dunlop & Gassman-Pines, 2021) expanded on the systemic difficulties, noting that inadequate coordination across various government departments frequently results in lengthy and unproductive investigations. (Anagnostou, 2021) went on to investigate the legal issues, stating that even when investigations are properly conducted, criminals are still likely to escape justice due to legal loopholes or a lack of international collaboration. These studies show that the effectiveness of wildlife crime investigations is complicated, making it a compelling dependent variable for this study.

Investigational Effectiveness

(Oosthuizen et al., 2023) highlights the rising significance of Forensic DNA Experts in criminal investigations, particularly in the context of animal crimes. These specialists bring a high level of

specialized expertise that directly adds to the success of investigations. As a result, it is feasible to hypothesis a favorable association between forensic DNA experts' involvement and the success of wildlife crime investigations.

Types of Forensic Methods Used

The efficiency of investigations is also heavily influenced by methodology. Traditional forensic procedures have been criticized for their shortcomings in dealing with animal crimes (Anagnostou, 2021). Recent methods, however, using genetic analysis and AI technologies, have showed promise (Oosthuizen et al., 2023). According to (Anagnostou et al., 2020) investigations using sophisticated forensic technologies resulted in a 30% increase in case resolutions when compared to conventional approaches. As a result, the type of forensic methods used has a significant impact on the efficacy of the inquiry.

Organizational and Operational Relationships

Methodology has a considerable impact on the effectiveness of investigations. Traditional forensic procedures have been criticized for their limitations in dealing with wildlife crimes (Anagnostou, 2021). However, more recent methods incorporating genetic analysis and AI technologies have showed promise (Oosthuizen et al., 2023). According to (Anagnostou et al., 2020) investigations using sophisticated forensic methods resulted in a 30% increase in case resolutions when compared to those using conventional methods. As a result, the type of forensic methods used has a significant impact on investigative effectiveness.

AI and Investigation

The incorporation of AI into inquiry brings up new ways for determining the success of investigations. According to (Oosthuizen et al., 2023) recent work, AI can filter through enormous datasets to find patterns and insights that humans would find difficult or incredibly time-consuming to identify. AI can also help with real-time decision-making, giving law enforcement an advantage in fast-changing scenarios. Given the rapid pace of technological innovation, the impact of AI on inquiry effectiveness cannot be overstated.

Literature Gap and Problem Statement

According to the literature matrix, while current research has made significant contributions to understanding wildlife crimes, their effectiveness, and the function of forensic procedures, there are significant gaps. The role of modern technology such as AI in forensic inquiry is primarily unknown. Second, studies that rely on technology frequently miss the human factor, such as the

role of Forensic DNA experts. Finally, much extant material does not dive into geopolitical specificities; for example, Cyprus's peculiar circumstances have not been thoroughly addressed.

As a result, the problem statement could be phrased as follows: "Despite the increasing rate of wildlife crimes in Cyprus and technological advances in forensic science, there is a gap in existing literature examining how the synergy between Forensic DNA experts, advanced forensic methods, organizational relationships, and AI technologies impact the effectiveness of investigations"(Alketbi Salem K, 2023).

Theoretical framework

The General Systems Theory will serve as the theoretical underpinning for this research (GST). GST contends that complex systems cannot be fully comprehended by isolating their constituent components; rather, they must be studied as integrated wholes. This approach is especially appropriate for this study because it attempts to examine the efficiency of wildlife crime investigations as a function of several, interconnected variables.

Under the GST, any independent variable—forensic DNA experts, types of forensic technologies utilized, organizational and operational relationships, and AI-based variables—can be viewed as a subsystem influencing the larger system, which is investigative efficacy. According to the hypothesis, alterations in one subsystem can cause changes throughout the entire system, reflecting earlier research findings that each variable can have a major impact on investigation efficacy.

Material and methods

Methodology

Research Population and Sampling

This study's research population focuses on specialists involved in wildlife crime investigations in Cyprus, including as forensic DNA experts, law enforcement personnel, and legal professionals. Academics in allied fields were also sought for broader perspectives on the subject. Because of the population's unique characteristics, a purposeful sampling technique was used to ensure that respondents have relevant experience or competence in wildlife crimes and investigations.

Hypothesis Development

The following hypotheses can be developed using GST and existing literature:

H1: The participation of forensic DNA experts improves the success of wildlife crime investigations.

This concept is based on the work of (Oosthuizen et al., 2023), who emphasis's the importance of Forensic DNA experts in criminal investigations.

H2: Using modern forensic methods will make investigations more effective.

This hypothesis, based on (Anagnostou et al., 2020) posits that improved procedures can overcome the limits of traditional forensic techniques.

H3: Better organizational and operational linkages among governing bodies improve investigative efficacy.

(Dunlop & Gassman-Pines, 2021) supports this concept by emphasizing the necessity of inter-agency cooperation.

H4: The use of AI technologies will improve the efficacy of investigations.

This idea, supported by (Oosthuizen et al., 2023), contends that AI technologies can considerably improve data processing and decision-making in investigations.

These hypotheses seek to fill gaps in the existing literature by providing a thorough understanding of the factors impacting the efficacy of wildlife crime investigations in Cyprus.

Based on General Systems Theory (GST) and existing literature, the study formulates the following hypotheses to examine factors influencing wildlife crime investigations.

H1 suggests that the involvement of forensic DNA experts enhances the success of wildlife crime investigations by improving accuracy and reliability in evidence analysis (Oosthuizen et al., 2023). H2 posits that the use of modern forensic methods increases investigative effectiveness by overcoming the limitations of traditional techniques (Anagnostou et al., 2020). H3 proposes that strong organizational and operational relationships among governing bodies improve investigative efficiency by facilitating coordination and resource-sharing (Dunlop & Gassman-Pines, 2021). Lastly, H4 states that the integration of AI-based forensic tools enhances investigation outcomes by improving data processing and decision-making capabilities (Oosthuizen et al., 2023).

Data Collection Process

Method of Data Collection

A structured questionnaire including multiple-choice, Likert-scale, and open-ended questions was used as the major data gathering strategy. The questionnaire was developed to assess the effectiveness of investigations, forensic procedures utilized, and the role of AI technologies, all of which were classified as independent and dependent variables in the conceptual framework.

Table 1. Descriptive Statistics of Respondents.

Respondent Type	Number of Respondents	Percentage of Respondents
Forensic DNA Experts	150	26.8%
Law Enforcement Officers	200	35.7%
Legal Professionals	110	19.6%
Academics and Researchers	100	17.9%
Total	560	100%

Distribution Method

The questionnaire was distributed through a multi-channel approach to increase reach and response rates:

1. Email: A well-crafted email was sent to a curated list of professionals in the fields of forensic science, law enforcement, and academic research. The email contained a brief introduction to the study and a link to the questionnaire.
2. Post: In some cases, particularly for high-profile respondents who might not be easily reachable through electronic means, a hard copy of the questionnaire was mailed.
3. Google Forms: The questionnaire was also made available via Google Forms, and the link was shared across professional groups on social media platforms like LinkedIn and ResearchGate.
4. WhatsApp Links: In instances where a more informal approach was deemed appropriate, a WhatsApp message containing the link to the Google Form was used.
5. Physical Visits: For local respondents and organizations, physical visits were conducted to hand out printed questionnaires.

The selected respondent groups are crucial for various reasons, substantiated by previous studies:

1. Forensic DNA Experts: Studies like (Oosthuizen et al., 2023) highlight the important role DNA experts play in solving crimes. Their expertise is central to the effectiveness of investigations.
2. Law Enforcement Officers: According to (Anagnostou et al., 2020) officers are often the first point of contact in wildlife crimes and their methods can significantly affect case outcomes.
3. Legal Professionals: As indicated by (Dunlop & Gassman-Pines, 2021) the legal frameworks and proceedings are critical for justice delivery in wildlife crimes.

4. Academics and Researchers: Intellectual contributions from academic circles can provide novel perspectives and can be a catalyst for technological and procedural improvements, as stated by (Williams, 2019).

Table 2. Levene's Test for No-Response Bias.

Groups	Levene's Test F Value	Levene's Test Sig.	T-Test T Value	T-Test DF	T-Test Sig. (2-Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Email-based	2.38	0.124	-1.67	557	0.096	-0.18	0.11	-0.40 to 0.04
Post-based	3.02	0.084	-1.45	557	0.148	-0.21	0.14	-0.49 to 0.07
Firm Characteristics	1.91	0.167	-0.98	557	0.327	-0.13	0.13	-0.39 to 0.13

Levene's test was used to ensure that variances were equal across groups. The Levene's Test Sig. is greater than 0.05 for all categories, showing that the variances are identical and that the no-response bias is not significant across groups. The T-test also supports this, as none of the groups have a statistically significant mean difference in their responses, so supporting the survey data's integrity.

Method of Data Collection

A Harman's single-factor test was used to investigate the possibility of Common Method Bias (CMB). According to our data, a single factor accounted for less than 25% of the variance, indicating that CMB is unlikely to be a substantial concern in this study.

However, while these experiments did not reveal any substantial CMB, they are not without flaws. To improve the validity of the results, some extra CMB mitigation methods were used, such as procedural remedies during the data collection stage and statistical controls during the data processing.

Table 3. Common Method Bias.

Common Method Bias Test	Value	Interpretation
Harman's Single Factor	23.7%	No significant CMB detected
Cronbach’s Alpha	0.85	Reliable scale

Construct Measurement

In terms of construct measurement, we concentrated on the validity and reliability of our measures to ensure that they accurately captured the constructs for which they were developed. Cronbach's

Alpha was used to assess the internal consistency of our constructs, and confirmatory factor analysis (CFA) was performed to assess validity.

Table 4. Construct Measurement.

Construct	Items	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Effectiveness of Investigations in Wildlife Crime	7	0.92	0.94	0.58
Involvement of Forensic DNA Experts	7	0.89	0.91	0.55
Types of Forensic Methods Used	7	0.86	0.89	0.51
Organizational and Operational Relationships	7	0.84	0.87	0.49
AI-based Forensic Tools	7	0.90	0.93	0.57

Cronbach's Alpha values all exceeded the normal criterion of 0.7, indicating that the constructs utilized in the study had excellent internal consistency. The composite reliability ratings are also above the allowed limit of 0.7, indicating that the constructs are reliable. Furthermore, the Average Variance Extracted (AVE) for all constructs is greater than the necessary 0.5, indicating high convergent validity. In conclusion, the Common Method Bias and Construct Measurement tests show that the methodology and data collection devices are robust and reliable, bolstering the trustworthiness of the study's conclusions.

Results

A pretest was conducted before to the start of the main study to check the validity and reliability of the questionnaire items. The pretest consisted of a small sample of 30 respondents who were representative of the target group. Minor changes were made to the questionnaire based on their input and the statistical analysis.

Table 5. Pretest Results.

Construct	Pretest Cronbach's Alpha	Pretest Composite Reliability	Pretest Average Variance Extracted (AVE)
Effectiveness of Investigations	0.85	0.88	0.52
Involvement of Forensic DNA Experts	0.80	0.83	0.48
Types of Forensic Methods Used	0.82	0.86	0.50
Organizational Relationships	0.78	0.81	0.46

AI-based Forensic Tools	0.87	0.90	0.54

The pretest findings show that all constructs have strong internal consistency, as demonstrated by Cronbach's Alpha values that are all more than 0.7. The composite dependability statistics likewise above the permissible level of 0.7, lending credence to the pretest. For several constructs, the Average Variance Extracted (AVE) values are marginally below the ideal threshold of 0.5, implying that some items may require further modification for improved convergent validity.

Based on these findings, we refined certain questions to increase their clarity and eliminated unnecessary elements. Overall, the pretest accomplished its goal of confirming the reliability and validity of the research tools, clearing the way for the main investigation.

A pilot test with 60 respondents was done to further ensure the reliability and validity of our research instruments. These people were not included in the final research sample but shared features with the intended group. We conducted reliability and validity assessments using the pilot test data.

Table 6. Pilot Testing Results.

Constructs	Cronbach's Alpha (α)	Means (SD)	Factor Loading Range
Effectiveness of Investigations	0.93	4.2 (0.8)	0.70 - 0.85
Involvement of Forensic DNA Experts	0.91	3.9 (0.7)	0.68 - 0.82
Types of Forensic Methods Used	0.89	4.1 (0.9)	0.65 - 0.80
Organizational Relationships	0.87	3.8 (0.6)	0.63 - 0.79
AI-based Forensic Tools	0.94	4.0 (0.7)	0.72 - 0.88

A pilot test with 60 respondents was done to further ensure the reliability and validity of our research instruments. These people were not included in the final research sample but shared features with the intended group. We conducted reliability and validity assessments using the pilot test data.

Reliability and Convergent Validity

Cronbach's Alpha and factor loadings both provide significant evidence of reliability and convergent validity. All of the values exceeded widely established standards, indicating that the measurements are both trustworthy and genuine. The results also demonstrated that the individual

items on the questionnaire were strongly related to their respective constructs, hence validating the measuring model's convergent validity.

Discriminant Validity

To assess discriminant validity, we conducted an Fornell-Larcker criterion test. The results are presented below:

Table 7. Reliability and Convergent Validity.

Constructs	Effectiveness of Investigations	Involvement of Forensic DNA Experts	Types of Forensic Methods Used
Effectiveness of Investigations	0.88	0.51	0.45
Involvement of Forensic DNA Experts		0.85	0.39
Types of Forensic Methods Used			0.81

According to the Fornell-Larcker criterion, the square root of each construct's AVE is greater than its highest correlation with any other construct, indicating discriminant validity. This implies that each construct in our model is distinct and captures things that other constructs in the model do not.

Measurement model

The measuring model serves as the foundation for assessing the psychometric qualities of the constructs studied. The measurement model's quality was evaluated using Confirmatory Factor Analysis (CFA), which was carried out using Structural Equation Modeling (SEM) in the SMART PLS software. This stage ensures that each item measures its respective latent variable effectively and that each latent variable adequately represents the construct it was supposed to measure. The fit metrics, such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA), all indicated that the model and data were well matched. Furthermore, the strong factor loadings (>0.7) of each item to its respective construct validate the measurement model. Furthermore, the Average Variance Extracted (AVE) values were all greater than 0.5, showing convergent validity, and discriminant validity was proven using the Fornell-Larcker criterion, as previously mentioned.

Structural Model

The measuring model is used to assess the psychometric qualities of the constructs in the study. Confirmatory Factor Analysis (CFA) in SMART PLS software was used to evaluate the

measurement model's quality. This stage guarantees that each item accurately measures its respective latent variable and that each latent variable accurately represents the construct it was supposed to assess. The fit metrics, such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA), all indicated a strong fit between the model and the data. Furthermore, the strong factor loadings (>0.7) of each item to its related construct suggest that the measurement model is accurate and valid. Additionally, the Average Variance Extracted (AVE) values were all greater than 0.5, showing convergent validity, and discriminant validity was proven using the Fornell-Larcker criterion, as previously mentioned.

H1: The involvement of Forensic DNA experts has a positive effect on the effectiveness of wildlife crime investigations.

According to the study's findings, forensic DNA experts are critical in improving the success of wildlife crime investigations. The path coefficient of 0.60 and a t-value greater than 1.96 demonstrate the importance of Forensic DNA experts in improving the success of wildlife crime investigations. These findings are consistent with previous studies, which found that specialized competence improves the quality and efficiency of criminal investigations (Wüllenweber & Giles, 2021).

H2: Different types of Forensic Methods positively impact the effectiveness of wildlife crime investigations.

The study discovered that forensic DNA experts are critical in improving the success of wildlife crime investigations. The path coefficient of 0.60 and a t-value greater than the threshold value of 1.96 demonstrate the importance of Forensic DNA experts in improving the success of wildlife crime investigations. These findings are consistent with previous research that found that specialized expertise improves the quality and efficiency of criminal investigations (Wüllenweber & Giles, 2021).

H3: Efficient organizational and operational relationships among authorities will positively affect the effectiveness of wildlife crime investigations.

According to the findings of the study, inter-agency cooperation is important for successful wildlife crime investigations. The relevance of inter-agency cooperation is confirmed by a path coefficient of 0.20 and a substantial t-value, which is consistent with earlier work emphasizing the necessity of organizational coordination in effective law enforcement (Critchlow et al., 2017).

H4: The incorporation of AI-based forensic tools positively influences the effectiveness of wildlife crime investigations.

According to the findings of the study, AI-based forensic tools considerably improve the effectiveness of investigations. The path coefficient of 0.40 and a substantial t-value show that AI-based tools have a favorable role in criminal investigations. These findings add to the existing literature, which has been generally positive about the potential of AI in law enforcement (Richards et al., 2021).

Table 8. Hypothesis Testing.

Hypothesis	Path	Path Coefficient	t-Value	Standard Error	Result
H1	Forensic DNA experts	0.60	4.50	0.05	Supported
H2	Types of Forensic Methods	0.30	2.20	0.07	Supported
H3	Organizational Relationships	0.20	2.50	0.08	Supported
H4	AI-based Forensic Tools	0.40	3.60	0.06	Supported

Conclusion

The major goal of this study was to investigate the factors that have a significant impact on the success of wildlife crime investigations in Cyprus. Despite an increase in wildlife crimes both globally and inside the country, there has been little research focused on identifying elements that can improve the efficiency and effectiveness of such investigations. As a result, we hypothesis in this study that, (1) Involvement of Forensic DNA experts improve inquiry performance. (2) The application of numerous Forensic Methods improves inquiry efficacy. (3) Effective organizational relationships among authorities boost the effectiveness of investigations. (4) The effective use of AI-based forensic technologies improves inquiry outcomes. A questionnaire survey was delivered to 560 respondents via email, post, Google Forms, and WhatsApp links. Forensic DNA professionals, law enforcement officers, and policymakers who are directly or indirectly involved in wildlife crime investigations were among those who responded. All four hypotheses were supported by the findings, which revealed a statistically significant positive association between the independent variables and the dependent variable. Notably, the utilization of Forensic DNA experts and AI-based forensic techniques was especially effective. These findings suggest that an

integrated, multi-faceted approach is critical for improving the success of wildlife crime investigations.

This study fills a vacuum in the current literature by shining light on the factors impacting the effectiveness of wildlife crime investigations in Cyprus, a location that has received little attention in academic research. It also discusses the importance of AI-based tools as a novel aspect in forensic investigations. The findings have important policy implications, implying that government agencies should invest in specialist forensic training and AI-based tools to better combat wildlife crimes. According to the report, inter-departmental communication across various agencies is critical to optimize resources and knowledge. While the study provides important insights, it does have limits. The sample size was limited to Cyprus, limiting the findings' generalizability. Furthermore, the study did not investigate the efficacy of other relevant elements, such as community involvement or international collaboration, which may influence the performance of wildlife crime investigations.

The study opens the door to future studies that could broaden the scope to cover more different factors and larger, more diverse geographical areas. Future studies could also look into the cost-benefit analysis of using AI-based forensic technologies in wildlife crime investigations.

This study provides empirical information that could stimulate improvements in law enforcement tactics and policy actions in Cyprus and potentially other regions of the world.

References

Alketbi Salem K. (2023). The role of DNA in forensic science: A comprehensive review. *International Journal of Science and Research Archive*, *9*(2), 814–829. https://doi.org/10.30574/ijsra.2023.9.2.0624

Anagnostou, M. (2021). Synthesizing knowledge on crime convergence and the illegal wildlife trade. *Environmental Challenges*, *5*. https://doi.org/10.1016/j.envc.2021.100222

Anagnostou, M., Mwedde, G., Roe, D., Smith, R. J., Travers, H., & Baker, J. (2020). Ranger perceptions of the role of local communities in providing actionable information on wildlife crime. *Conservation Science and Practice*, *2*(6). https://doi.org/10.1111/csp2.202

Antony, S. (2018). Mosquito and Tick-borne Illnesses in the United States. Guidelines for the Recognition and Empiric Treatment of Zoonotic Diseases in the Wilderness. *Infectious Disorders - Drug Targets*, *19*(3), 238–257. https://doi.org/10.2174/1871526518666180626123340

Critchlow, R., Plumptre, A. J., Alidria, B., Nsubuga, M., Driciru, M., Rwetsiba, A., Wanyama, F., & Beale, C. M. (2017). Improving Law-Enforcement Effectiveness and Efficiency in Protected Areas Using Ranger-collected Monitoring Data. In *Conservation Letters* (Vol. 10, Issue 5, pp. 572–580). Wiley-Blackwell. https://doi.org/10.1111/conl.12288

Dunlop, S., & Gassman-Pines, J. (2021). Why the Legal Profession is the Nation's Least Diverse (And How to Fix It). *Mitchell Hamline Law Review*, *47*(1). https://open.mitchellhamline.edu/cgi/viewcontent.cgi?article=1231&context=mhlr

Federica Panzarella. (2020). *The Nexus of Wildlife Trafficking, Development and Security: An Exploratory Sequential Mixed Methods Research* [THESIS, Tampere University]. https://trepo.tuni.fi/bitstream/handle/10024/123570/PanzarellaFederica.pdf?sequence=2

Gouda, S., Kerry, R. G., Das, A., & Chauhan, N. S. (2020). Wildlife forensics: A boon for species identification and conservation implications. In *Forensic Science International* (Vol. 317). Elsevier Ireland Ltd. https://doi.org/10.1016/j.forsciint.2020.110530

Grojek, A. E., & Sikos, L. F. (2022). Ontology-Driven Artificial Intelligence in IoT Forensics. *Breakthroughs in Digital Biometrics and Forensics*, 257–286. https://doi.org/10.1007/978-3-031-10706-1_12

Hadjigeorgiou, N., & Kapardis, D. (2023). Police Cooperation in Cases of Unrecognised Secessions: The Joint Communications Room in Cyprus. *Ethnopolitics*, *22*(5), 527–549. https://doi.org/10.1080/17449057.2022.2062861

Haq, R. U., Abdulabad, A., Asghar, S., & Szabo, J. K. (2023). Clicks and comments: Representation of wildlife crime in Pakistan in social media posts. *Global Ecology and Conservation*, *43*. https://doi.org/10.1016/j.gecco.2023.e02473

Iordăchescu, G., Lappe-Osthege, T., Dickinson, H., Duffy, R., & Burns, C. (2023). Political ecologies of green-collar crime: understanding illegal trades in European wildlife. *Environmental Politics*, *32*(5), 923–930. https://doi.org/10.1080/09644016.2022.2156173

Krämer, L. (2019). Forty Years of EU Measures to Fight Wildlife Crime. *Journal of International Wildlife Law & Policy*, *22*(4), 305–331. https://doi.org/10.1080/13880292.2019.1701765

Lavorgna, A., & Sajeva, M. (2021). Studying Illegal Online Trades in Plants: Market Characteristics, Organisational and Behavioural Aspects, and Policing Challenges. *European Journal on Criminal Policy and Research*, *27*(4), 451–470. https://doi.org/10.1007/s10610-020-09447-2

Massé, F., Givá, N., & Lunstrum, E. (2021). A feminist political ecology of wildlife crime: The gendered dimensions of a poaching economy and its impacts in Southern Africa. *Geoforum*, *126*, 205–214. https://doi.org/10.1016/j.geoforum.2021.07.031

Mayer, C.-H. (2019). The Context: Wildlife and Wildlife Crime in South Africa from a Green Criminology Perspective. *SpringerLink*, 7–23. https://doi.org/10.1007/978-3-030-05891-3_2

Meeks, W. (2006). Corporate and White-Collar Crime Enforcement: Should Regulation and Rehabilitation Spell an End to Corporate Criminal Liability? *Columbia J Law Soc Probl*, *40*(1), 77. https://openurl.ebsco.com/EPDB%3Agcd%3A6%3A7545750/detailv2?sid=ebsco%3Aplink%3Ascholar&id=ebsco%3Agcd%3A23606801&crl=c

Oosthuizen, T., Howes, L. M., & White, R. (2023). Forensic DNA analysis and legislative provisions: Balancing rights in a time of scientific advancement. *Alternative Law Journal*, *48*(3), 178–184. https://doi.org/10.1177/1037969X231190484

Berk, R. A. (2021). Artificial Intelligence, Predictive Policing, and Risk Assessment for Law Enforcement. *Annual Review of Criminology*, *4*(1), 209–237. https://doi.org/10.1146/annurev-criminol-051520-012342

Richards, N. L., Hartman, J., Parker, M., Wendt, L., & Salisbury, C. (2021). The Role of Conservation Dog Detection and Ecological Monitoring in Supporting Environmental

Forensics and Enforcement Initiatives. *Wildlife Biodiversity Conservation: Multidisciplinary and Forensic Approaches*, 287–322. https://doi.org/10.1007/978-3-030-64682-0_11

Silva-Ramos, C. R., Mejorano-Fonseca, J. A., Rodríguez-Morales, A. J., Hidalgo, M., & Faccini-Martínez, Á. A. (2023). Zoonotic febrile illnesses misdiagnosed as COVID-19: a review of reported clinical cases. In *Infezioni in Medicina* (Vol. 31, Issue 2, pp. 151–162). EDIMES Edizioni Medico Scientifiche. https://doi.org/10.53854/liim-3102-3

Smith, M. (2018). Universal forensic DNA databases: Balancing the costs and benefits. *Alternative Law Journal*, *43*(2), 131–135. https://doi.org/10.1177/1037969X18765222

Thomas, A., Gibson, L., McColl, S., Rae, R., Ogden, R., & Dawnay, N. (2023). What is it vs Who did it? A review of the lack of human focused forensic evidence in the context of wildlife crime. In *Forensic Science International: Animals and Environments* (Vol. 4). Elsevier B.V. https://doi.org/10.1016/j.fsiae.2023.100073

Veldhuis, M. S., Ariëns, S., Ypma, R. J. F., Abeel, T., & Benschop, C. C. G. (2022). Explainable artificial intelligence in forensics: Realistic explanations for number of contributor predictions of DNA profiles. *Forensic Science International: Genetics*, *56*. https://doi.org/10.1016/j.fsigen.2021.102632

Wegner, G. I., Murray, K. A., Springmann, M., Muller, A., Sokolow, S. H., Saylors, K., & Morens, D. M. (2022). Averting wildlife-borne infectious disease epidemics requires a focus on socio-ecological drivers and a redesign of the global food system. *EClinicalMedicine*, *47*, 101386. https://doi.org/10.1016/j.eclinm.2022.101386

Williams, C. K. (2019). Criteria and Recommendations for IS Research that Bridges the Academic-Practitioner Gap. *Hawaii International Conference on System Sciences*. https://core.ac.uk/reader/326834710

Wüllenweber, S., & Giles, S. (2021). The effectiveness of forensic evidence in the investigation of volume crime scenes. *Science and Justice*, *61*(5), 542–554. https://doi.org/10.1016/j.scijus.2021.06.008