Kasetsart Journal of Social Sciences

journal homepage: http://kjss.kasetsart.org

Crime scene management for drone incidents

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Article Info

Abstract

Criminals could potentially exploit drones to perpetrate illicit activities as they have become increasingly accessible. This research aims to examine patterns of drone-related crime and develop guidelines for effective crime scene management in drone incidents for first responders. Qualitative research methods were employed to collect data, including document analysis, in-depth interviews with ten key informants from law enforcement and forensic divisions, and a focus group discussion with seven experts in policing and digital forensics.

The research findings revealed that the patterns of drone-related crime could be classified into five categories, including (1) personal rights violation, (2) violations of aviation laws and regulations, (3) contraband smuggling, (4) crimes against persons and terrorism, and (5) aerial reconnaissance to facilitate criminal acts. The crime scene management of drone incidents involves three main phases, namely, (1) incident notification and preparation, (2) crime scene approach and protection, and (3) evidence collection. Law enforcement officers should be aware of the key components of drones and the dangers at the incident scene, conduct appropriate evidence collection, and formulate accurate evidentiary inquiries for forensic examination. It is suggested that future research should further develop these findings into practical applications by creating a standardised manual for crime scene management for drone incidents in Thailand.

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Introduction

Drones, or unmanned aerial vehicles (UAVs), have transitioned from primarily military applications to widespread civilian and commercial use due to their increasing accessibility and affordability (Sayler, 2015).

It is reported that the global drone market is expected to increase from USD 25.7 Billion in 2024 to USD 54.6 Billion by 2030 (Zanelli & Bödecker, 2024). Drones have been used across various industries, including aerial photography, delivery services, agriculture, construction, emergency response, and law enforcement

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such as police surveillance and crime scene investigation (Dolata & Schwabe, 2023; Valdovinos et al., 2016). However, the ongoing proliferation of drones presents significant challenges to public safety and security due to the potential for misuse in criminal activities.

Particularly, drones could be misused to facilitate criminal activities, such as drone assassination (Rogers & Kunertova, 2022), contraband smuggling (National Institute of Justice, 2023), stalking and privacy violations (Mercer, 2019; Wattanarung, 2019), and terrorist attacks (Army Recognition, 2024; Peck, 2023). In Thailand, authorities have recognised drone threats, evidenced by multiple incidents of drones detected operating near airports and restricted areas (Ngamkham, 2017). Notably, drones are suspected of being used for reconnaissance before insurgent attacks in the southern border region. For instance, an ambush involving gunfire and grenades occurred shortly after a suspicious drone was observed flying near a military base in Yala in 2023 (ThaiPBS, 2023). Another unauthorised flying drone was found later that year at Chana Police Station in Narathiwat (MGR Online, 2023).

Crime scenes involving drone incidents can be hazardous, especially when drones carry explosive or chemical payloads (Reiber, 2018). Such substances pose severe risks to first responders, such as police officers, crime scene investigators, and rescuers. Explosive devices risk detonation if mishandled, leading to catastrophic damage and loss of life. Chemical agents may be toxic, corrosive, or environmentally hazardous, posing health risks through inhalation, skin contact, or environmental contamination. Furthermore, an armed drone's presence exacerbates the dangers, as premature attempts to retrieve or disarm it could inadvertently trigger payload delivery. Even the multirotor propellers could pose laceration hazards if the drone unexpectedly takes flight (Duma et al., 2021). In addition to immediate threats from drones, the crime scene investigation of such incidents requires meticulous attention to detail, as drones can leave behind a variety of physical, digital, and biological evidence that must be carefully collected and analysed to reconstruct the events and identify the offenders.

Given these risks, developing specific protocols for crime scene management related to drone incidents are crucial, yet the Royal Thai Police currently lacks such guidelines. The lack of standardised procedures for handling drone-related crime scenes further complicates the situation, particularly in jurisdictions like Thailand, where such incidents are relatively new and under-regulated. Traditional crime scene management practices may be insufficient to address the specific challenges posed

by drones, necessitating the development of specialised protocols that consider the unique characteristics of drone technology. These protocols must encompass all stages of crime scene management, from the initial response and hazard assessment to evidence collection, preservation, and analysis. Therefore, this paper aims to examine how drones could facilitate criminal offences and propose guidelines for first responders to ensure safe and effective crime scene management in drone incidents.

Literature Review

The primary legal framework for drone regulations in Thailand is outlined in the Air Navigation Act B.E. 2497 (1954) and the Announcement of the Ministry of Transport on Rules to Apply for Permission and Conditions to Control and Launch Unmanned Aircraft in the Category of Remotely Piloted Aircraft B.E. 2558 (2015). Briefly, all drones must be registered with the National Broadcasting Telecommunications Commission (NBTC) and Civil Aviation Authority of Thailand (CAAT) prior to the flight if they either have a camera or weigh two kilogrammes or more. During flight, it is prohibited to fly in a manner that endangers life, property, or peace, enter restricted areas, fly within nine kilometres of airports or over 90 metres high, violate privacy, carry dangerous items, or fly within 30 metres of people (The Civil Aviation Authority of Thailand [CAAT], 2022). Notably, Thailand has designated several no-fly zones where drone operations are strictly prohibited unless proper authorisation is obtained. These restricted areas include airports and their vicinity, military bases and installations, Royal Palaces and Government Houses, and especially the VTR1 area, marked by a 19-kilometre radius from the Victory Monument, encompassing Bangkok's central districts (CAAT, 2022). A study by Roolak (2017) particularly recognises a surge in unauthorised drone flights in restricted areas and violations of aviation laws in Thailand, which could pose severe threats to national security in both military and civilian contexts.

The literature review on drone-related criminal activities reveals a growing concern in the field of public security. Yaacoub et al. (2020) provide a comprehensive analysis of drones and their potential for misuse, categorising drone-related crimes into physical and logical attacks. Physical attacks encompass a range of activities from assassinations and privacy violations to drug smuggling and property damage, while logical attacks focus on cyber-attacks and

signal interference caused by drones. These physical attacks align with a study by Wattanarung (2019) that examines the legal measures against drone misuse, addressing privacy violations, invasion, assaults, and sexual harassment. Furthermore, Caldwell et al. (2020) highlight the emerging threat of AI-enabled autonomous drone swarms. Their research underscores the potential for these technologically advanced systems to conduct complex operations without human control, potentially causing more significant damage and posing greater challenges for law enforcement. The authors assess that the threat of drone swarms is highly likely and could directly endanger lives and property, such as assassinations or attacks on passenger aircraft.

In terms of crime scene management, the Royal Thai Police currently follows guidelines set by the National Forensic Science Technology Center [NFSTC] (2013). These guidelines outline a comprehensive crime scene investigation protocol that begins with establishing control over the area, ensuring scene safety, and separating potential witnesses. Investigators then methodically conduct an initial survey, noting priorities before implementing measures to preserve the untouched scene integrity and restrict evidence contamination. A systematic search visually records and documents all items of evidentiary value through detailed illustrations, photography, and videography. Physical evidence is meticulously collected, packaged, and its chain of custody initiated. After a final survey confirming thorough crime scene processing, the area is released to the owner. These protocols initially served as the theoretical framework for this research. Nevertheless, the researcher identified that these protocols involved an excessive number of steps, making it challenging to structure the research findings effectively. Consequently, the researcher adopted an alternative framework proposed by Gehl and Plecas (2017), which was originally developed for criminal investigation. This framework divides the criminal event into three main stages of time where evidence can originate: (1) the pre-crime stage, which includes planning, note-taking, research, and preparation of supplies; (2) the criminal event stage, which involves the transfer of physical evidence at the crime scene, the victim, and the suspect; and (3) the post-crime stage, which encompasses actions such as avoiding apprehension, discarding or cleaning up evidence, and dealing with the proceeds of the crime.

Building on this framework, the researcher developed a tailored theoretical framework for managing crime scenes involving drone incidents, structured into three primary phases: (1) the pre-crime scene approach phase, which involves incident notification and preparation, (2) the crime scene approach phase, which focuses on the approach to and protection of the crime scene; and (3) the post-crime scene approach phase, which is centred on the collection of evidence. This refined framework provides a more focused and applicable approach to managing the complexities of drone-related crime scenes.

Notably, the International Criminal Police Organization [INTERPOL] (2020) launched a framework for responding to a drone incident, focusing on officer safety and drone seizure with careful handling of evidence at the scene. It is mandatory to recognise that hazardous or explosive substances in the payload or even the drone's battery could cause injuries to first responders. Furthermore, the drone propellers could be dangerous if they are still rotating; therefore, a heavy sheet or net is recommended to cover the drone so as to prevent it from operating.

In terms of digital evidence, MacDermott et al. (2020) emphasise that crime scene investigators must understand the types of data drones store, including flight data, capabilities, geolocation, sensors, communication systems, and controllers, to properly handle forensic evidence in drone-related crime scenes. Additionally, Al-Room et al. (2021) explore the pieces of evidence gathered from the laboratory forensic examination of six brands of drones, including location history, GPS coordinates, flight paths, photo and video recordings, and data from drone controllers in both physical storage and cloud platforms. These findings provide a crucial framework for crime scene investigators, the primary stakeholders in this research, to understand and interpret evidence obtained from drone incidents.

Methodology

Data Collection

This research employed qualitative research methods to collect data as follows:

1. Documentary analysis was conducted by reviewing legal statutes, Supreme Court judgments, news, articles, theses, research papers, and online media related to the use of drones to commit or facilitate a crime both from domestic and international contexts. The analysis mainly focused on patterns of crime associated with drones and forming proper questions for in-depth interviews.

2. In-depth interviews were performed with ten key informants from various organisations dealing with drone-related issues and digital forensics, including the Defence Technology Institute, Bangkok Metropolitan Police Bureau, Drone Operations and Anti-Drone Task Force (Royal Thai Police), Crime Scene Investigation Division and Digital Forensics Division (Office of Police Forensic Science), Central Institute of Forensic Science, Navaminda Kasatriyadhiraj Royal Air Force Academy, and Civil Aviation Authority of Thailand. The interviews aimed at gathering their perspectives on drone-related crime trends and crime scene management for drone incidents.

3. After in-depth interviews, a focus group discussion was then conducted to brainstorm ideas and opinions to refine research results and guidelines for crime scene management for drone incidents. The participants included seven experts from the fields of law enforcement, drone technology in policing, crime scene management, and digital forensics. The experts were from the Royal Police Cadet Academy, Digital Forensics Division (Office of Police Forensic Science), Bangkok Metropolitan Police Bureau, and Drone and Anti-Drone Task Force (Royal Thai Police).

In terms of in-depth interviews and the focus group discussion, a semi-structured interview and discussion guide was developed as a tool to collect data. Prior to data collection, the research tool was reviewed and approved by advisers and the Institutional Review Board of the Faculty of Forensic Science, Royal Police Cadet Academy (FSRPCA-IRB-65033). A set of open-ended questions was employed to allow participants to give details about drone-related crime and trends in Thailand including patterns of crime scene that first responders might encounter. Furthermore, they were asked to provide a comprehensive approach for crime scene management, including crucial steps to safely enter the scene and appropriately collect forensic evidence for criminal investigation.

Data Analysis

The data gathered from in-depth interviews and the focus group discussion were recorded, transcribed, and sent back to the participants for accuracy and validity in accordance with the member checking technique. Furthermore, data triangulation was applied to enhance confidence in research results by comparing data from the interviews, focus group discussion, and extended document analysis. Thematic analysis was then employed to categorise themes and patterns of research findings.

Results and Discussion

Patterns of Drone-Related Crime

While there are no official statistical reports on illegal drone activities in Thailand, the researcher attempted to gather information by sending letters to all police regions. The responses indicated that no data or records on drone criminal activities are available. However, some key informants in this research acknowledged the occurrence of numerous drone incidents, particularly those intended to inflict physical harm on others, but they expressed a desire to keep these incidents confidential to prevent potential copycat crimes. Despite this lack of information in Thailand, a document review indicates that the threat posed by drones is escalating. For instance, DroneSec, a drone intelligence firm, reported a significant increase in the number of drone-related incidents, with 2,554 major illicit drone incidents recorded in 2022 alone—an increase of 60 percent from 2021 (Unmanned Airspace, 2023). This includes a 140 percent rise in residential incidents, a 130 percent rise in incidents at event spaces or areas of interest, a 100 percent increase in incidents involving government and critical infrastructure, a 50 percent increase in border incidents, and a 40 percent rise in prison deliveries. These incidents mostly involve drones being used to transport weapons, narcotics, and contraband across borders or into restricted areas, as well as drones infringing on the airspace of manned aircraft or violating no-fly zones such as hospitals and airports.

In a similar vein, a 2023 report from the UK estimates that over 6,000 drone incidents were reported to the police, with approximately 31 percent involving drones suspected of delivering contraband to prisons, 13 percent involving drones flying in flight-restricted zones and causing significant financial losses in aviation, and numerous reports of drones being used for privacy violations or operating recklessly, potentially causing accidents (Jackman & Hooper, 2023). It is clear that the trend of drone incidents is on the rise, and the findings from document research provided a foundation for the data analysis in this study in terms of drone-related crime patterns. Consequently, the research findings revealed five distinct patterns of drone-related crime (Table 1).

Table 1 Patterns of drone-related crime

Offence	Impact / Harm	Patterns
Personal rights violation	- Deprivation of rights - Invasion - Sexual harassment	- Aerial invasion - Voyeurism - Stalking - Non-consensual production of pornography
Violations of aviation laws and regulations	- Abuse of national security - Impact on aviation industry - Loss of life and property (in case of collision)	- Unauthorised use of drones in the prohibited, restricted, and danger zones - Flying in airport zones - Altitude limit violation
Contraband smuggling	- Disturbing peace and order of the penitentiary - Breach of border security	- Contraband smuggling into prisons by drone deliveries - Drug smuggling across borders by drone deliveries
Crimes against persons and terrorism	- Loss of life - Injuries - Public fear and panic	- Drone assassination - Carrying bombs or hazardous materials - Drone accidents - Hoax terrorism
Aerial reconnaissance to facilitate criminal acts	- Crimes against person and property - Terrorist attacks - Other types of drone-related crime	- Drone spying - Aerial reconnaissance for criminal or terrorist purposes - Using drone to facilitate theft or robbery

Personal Rights Violations

Drone technology has enabled new forms of personal rights violations, particularly in the realm of privacy. Drones equipped with cameras can invade personal spaces, capturing images and video without consent. This intrusive form of voyeurism and surveillance allows perpetrators to illegally monitor an individual's movements and activities from a distance. A key informant mentioned an instance where a private detective used drones to illegally stalk victims and report their activities to employers. This invasion of privacy can escalate to sexual harassment when drones are used to record compromising situations or produce non-consensual sexually explicit material. These findings are consistent with the privacy issues and sexual offences highlighted in previous literature (Mercer, 2019; Wattanarung, 2019).

Violations of Aviation Laws and Regulations

Drones pose severe threats through violations of aviation laws and regulations, ranging from compromising national security to disrupting aviation operations. Unauthorised drone flights in prohibited, restricted, and danger zones, as well as intrusions into airport airspace, not only breach airspace regulations but also raise significant safety concerns. The findings revealed numerous cases of drones flying in the VTR1 restricted area, resulting in criminal liability and fines.

The majority of key informants indicated that these violations often stemmed from operators' lack of awareness and knowledge about aviation laws, regulations, and the locations of danger, prohibited, and restricted areas. Altitude limit violations further exacerbate these risks, increasing the chances of collisions with manned aircraft, which could lead to catastrophic loss of life and property. For instance, an Emirates Airlines Airbus A380-800 allegedly collided with a drone while landing in France in August 2023, resulting in substantial damage to the nose gear and wing (Tolba, 2023). This incident aligns with the concerns raised by Roolak (2017) regarding drone-related violations of aviation laws and regulations.

Contraband Smuggling

Drones are increasingly used for contraband smuggling, presenting challenges for law enforcement and security agencies in Thailand. One prominent pattern involves the delivery of contraband into prisons, where drones are employed to drop items such as mobile phones, weapons, and drugs directly into prison yards, consistent with previous research (Yaacoub et al., 2020). This not only disrupts the peace and order of penitentiaries but also complicates inmate behaviour management and prison security. However, most key informants reported that no contraband deliveries to prisons were successful due to anti-drone systems.

Nevertheless, they warned that officers should remain vigilant, as drones are becoming increasingly quiet, potentially leading to successful deliveries in the future. Another concerning pattern is the use of drones for drug smuggling across Thailand's borders. The key informants revealed that criminal networks in Thailand and neighbouring countries exploit drones' capability to carry substantial payloads over long distances for narcotics transportation.

Crimes Against Persons and Terrorism

Drones have become a concerning tool for perpetrating crimes against persons and acts of terrorism. Drone assassinations now pose a real threat, potentially allowing perpetrators to carry out attacks from a safe distance. An example is the attempted assassination of the Venezuelan President in 2018, using a couple of small drones equipped with explosives (Rosati & Bronner, 2018). Drones carrying hazardous materials also pose significant risks to public spaces and critical infrastructure, enabling terrorists to deliver destructive payloads with precision and minimal risk to themselves. While there have been no reported intentional drone attacks for assassination and physical harm in Thailand according to public reports or news, two key informants revealed that such cases have occurred. However, they could not provide more information as these incidents remain classified.

Drone accidents, while not always intentional, can result in severe injuries when these devices malfunction or are operated recklessly in populated areas. The velocity of drones makes them capable of inflicting significant physical harm. Moreover, the rotors can act as blades, potentially lacerating skin or tissue upon impact. For example, a drone accident at a 5K race in Quebec resulted in a runner being struck in the head by a falling photography drone, causing a whiplash injury (Rosenblatt, 2016). Key informants noted that drone accidents could prove fatal if the damage occurs to crucial areas of the victim's body, such as the head or neck, or if the victim is an infant or young child.

In addition to direct attacks, drones can be employed for hoax terrorism, where harmless devices create fear and disruption. This tactic is exploited by those seeking to cause panic without the immediate risk of violence. A key informant cited an incident where a suspicious drone was found in front of a hotel during a summit conference in Bangkok. While initially feared to be a bomb, no explosives were present. Police officers believed the drone was intentionally used to create panic. This incident bears similarities to an event in Tokyo in 2015, where a drone with traces of radiation was discovered on the roof of the official residence of the Japanese Prime Minister (The Guardian, 2015). Both cases illustrate how drones can be used to instil fear and disrupt public events, even when posing no immediate physical threat.

Aerial Reconnaissance to Facilitate Criminal Acts

Using drones for aerial reconnaissance to facilitate criminal acts is a significant pattern in drone-related crime. This pattern manifests in various forms, including drone spying for intelligence gathering in contraband and drug smuggling operations, aerial surveillance to plan terrorist attacks, as seen in Thailand's southern border provinces (ThaiPBS, 2023; MGR Online, 2023), and facilitating theft and robbery, exemplified by an ATM robbery in France (Singh, 2022). Notably, the key informants emphasised the use of drones for aerial surveillance in terrorism. They reported that terrorist attacks in Thailand often occurred after a drone was observed flying near the intended target. In some instances, a more sinister tactic was employed: a drone equipped with explosives would be deliberately placed to lure officers to inspect it, while another bomb was concealed along the route to the drone. This secondary device was intended to detonate when security personnel approached, potentially causing significant casualties.

Crime Scene Management

The findings revealed that crime scene management for drone incidents involving criminal activities encompass three main phases in accordance with the theoretical framework, including (1) incident notification and preparation, (2) crime scene approach and protection, and (3) evidence collection. Details are illustrated in Figure 1 as follows:
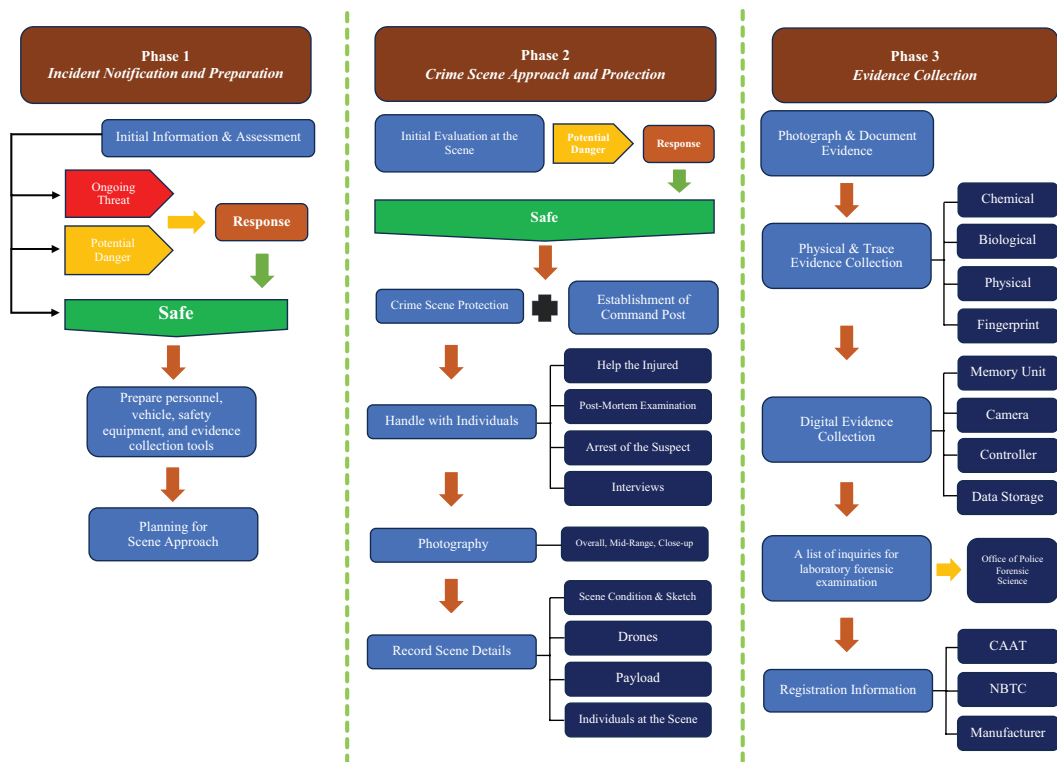
Figure 1 Proposed crime scene management guidelines

Phase 1: Incident Notification and Preparation

Before entering the scene, crime scene investigators are tasked with gathering detailed information about the incident from the dispatcher, including time, location and drone characteristics. They must assess the drone's status, determining whether it is airborne, crashed or stationary, and record relevant details such as casualties and injuries. Situational awareness is crucial, with officers evaluating the safety of the incident site. Based on the initial information, a preliminary evaluation is conducted to hypothesise about the type of crime involved, guiding subsequent investigation strategies. Throughout the process, officer safety remains a top priority, especially in potentially hazardous situations. The scene must be completely secure before approaching. This is consistent with the guidelines provided by INTERPOL (2020). If there are ongoing threats or potential dangers at the scene, investigators are required to wait until first responders have fully cleared the area and declared it safe.

The protocol emphasises the importance of preparedness and planning, ensuring that personnel are equipped with necessary vehicles, safety equipment, and evidence collection tools and set a plan to identify, search, and collect evidence before approaching the scene. Additional tools in this research, apart from the crime scene toolkit recommended by the NFSTC (2013), include binoculars, high-zoom cameras, or drones equipped with thermal imaging camera for initial site assessment. Moreover, radio and phone signal jammers (specifically for 2.4 GHz and 5.8 GHz frequencies commonly used by commercial drones) are suggested for crime scene investigators to cut the communication system between the drone and controller. Canvas, netting, or metal sheets are recommended to protect officers from potential harm caused by functioning drones at the scene, whether from their rotors or potential crashes, consistent with previous research mentioning this type of harm by drone (INTERPOL, 2020; Duma et al., 2021). Meanwhile, Faraday bags may be required if the mobile phone controlling the drone is expected to be found at the scene.

Phase 2: Crime Scene Approach and Protection

The process begins with an initial assessment upon approaching the scene to confirm safety, based on details from Phase 1. Most key informants recommended the use of signal jammers to disrupt drone-controller communication.

Additionally, the employment of remote assessment tools such as binoculars, high-zoom cameras, or thermal imaging drones is advised for maximum safety, if possible. If the drone is found fallen or stationary at the scene, covering it with canvas, netting, or metal sheets is recommended to prevent potential harm if it is suspected to be active or operational.

Crime scene protection involves establishing a three-tiered cordoned area to safeguard the crime scene. The innermost area is reserved for investigators, a middle tier for the command post, and an outer area for media and local residents. This setup aligns with the scene control guidelines established by the NFSTC (2013). Particular attention is given to the careful management of individuals at the scene, prioritising assistance for the injured while maintaining the integrity of evidence. Meanwhile, handling suspects found at or near the scene involves the immediate separation of potential perpetrators from control devices that may contain crucial evidence, such as controllers or mobile phones. Preliminary interviews should be conducted with victims, witnesses, and suspects at the scene.

Throughout the process, meticulous documentation is stressed, including recording arrival times, environmental conditions, and detailed observations of the scene and the drone itself, such as type, make, model, and serial number. Forensic photography principles should be applied, capturing images from overall, mid-range, close-up, and close-up with scale (INTERPOL, 2020). Additionally, a scene sketch is required for further use in the courtroom.

Phase 3: Evidence Collection

This phase involves the systematic recording and collection of evidence to ensure that all relevant information is captured and preserved for investigative and legal purposes. The head of the investigation team plays a crucial role in describing the crime scene, identifying potential hazards, defining objectives, and assigning specific tasks to team members. They also outline the methods for searching and collecting evidence to ensure thoroughness and accuracy (NFSTC, 2013).

Consistent with INTERPOL (2020) guidelines, key informants recommended that physical and trace evidence be collected first, as such could be destroyed or contaminated by weather conditions or other factors. For instance, DNA and fingerprints should be collected from the drone's legs or propellers. Handling the drone at the crime scene requires extreme caution, even when confirmed to be completely inactive.

The procedure includes carefully disassembling and collecting components such as the battery, camera, external memory, and SIM cards.

Key informants noted that most drones are powered by lithium-ion batteries, which are susceptible to water. Investigators must be aware of the potential hazards, such as battery leakage or overheating that could lead to explosions. If the drone controller is seized, all data must be safeguarded against potential data loss or remote wiping. For example, a mobile phone used as a controller must be put in flight mode and collected in a Faraday bag to preserve crucial data for the investigation, including flight logs, flight paths, location history, pictures, and videos captured from the drone. All these are important evidence, as highlighted in a study by MacDermott et al. (2020). Additionally, any payloads such as drugs, explosives, or other contraband need to be documented and sampled carefully, considering their specific characteristics and potential dangers.

After leaving the scene, investigators should ensure that all evidence and details are comprehensively gathered. They should then provide a list of inquiries for laboratory examination, based on the offence and information required from the evidence, and send it with the evidence to the Office of Police Forensic Science. Furthermore, registration information should be requested from the National Broadcasting and Telecommunications Commission (NBTC) and the Civil Aviation Authority of Thailand (CAAT), which are the regulators in Thailand, for the identification of the drone owner or operator. The manufacturer company should also be contacted to collect registration details and the purchase and aftersales service history of the drone owner or operator.

Conclusion and Recommendation

The accessibility of drones has opened new avenues for criminals to engage in illicit activities. This research has examined patterns of drone-related crime and proposed guidelines for crime scene management in drone incidents specifically for first responders and crime scene investigators. Utilising qualitative research methods, including document analysis, in-depth interviews, and a focus group discussion, this study has identified five categories of drone-related crime: (1) personal rights violations, (2) violations of aviation laws and regulations, (3) contraband smuggling, (4) crimes against persons and terrorism, and (5) aerial reconnaissance to facilitate criminal acts.

Effective crime scene management for drone incidents involves three primary phases: (1) incident notification and preparation, (2) crime scene approach and protection, and (3) evidence collection. Before proceeding to the scene, crime scene investigators must thoroughly gather detailed information about the incident and ensure both themselves and their equipment are fully prepared. When approaching the scene, law enforcement officers must remain highly vigilant of drone components and potential dangers, while also preventing uninvolved bystanders from contaminating the area. Once at the crime scene, crime scene investigators must ensure thorough evidence collection, with particular attention to the vulnerability of digital evidence, handling it with care, and formulating precise inquiries for laboratory forensic examination.

It is recommended that the Royal Thai Police should prioritise training and educating police officers on responding to incidents, accidents, or cases involving drones. This includes establishing protocols for countering drones and managing crime scenes where drones are found. Furthermore, policymakers should mandate that companies manufacturing drones and electronic components with branches, offices, or dealers in Thailand must register and create a database for the buying and selling of electronic parts used in the production or assembly of unmanned aerial systems. This will facilitate the tracking of ownership of such electronic components, similar to the registration of SIM cards and mobile phone numbers, especially when self-assembled drones are found at crime scenes. The NBTC and CAAT should be authorised to create and inspect such a database and link it with the Royal Thai Police's database to enable direct search and verification through the police information system.

Future research should focus on translating these findings into practical applications, including the development of a standardised manual for crime scene management of drone incidents in Thailand. Such a manual would provide law enforcement with a consistent framework to effectively address and mitigate the unique challenges posed by drone-related crimes. Additionally, it is important to raise public awareness of drone-related threats and appropriate response measures, as the first person to witness an incident may not be a law enforcement officer but an ordinary citizen. Meanwhile, the public should be well educated on how to operate drones legally to prevent potential threats.

Conflict of Interest

The author declares that there is no conflict of interest.

Fundings

References

Al-Room, K., Iqbal, F., Baker, T., Shah, B., Yankson, B., MacDermott, A., & Hung, P. C. K. (2021). Drone forensics: A case study of digital forensic investigations conducted on common drone models. *International Journal of Digital Crime and Forensics (IJDCF)*, *13*(1), 1–25. https://doi.org/10.4018/IJDCF.2021010101

Army Recognition. (2024, March 14). Analysis: Myanmar fighters use home-made UAV to bomb junta forces. Analysis Defense and Security Industry. https://armyrecognition.com/focus-analysis-conflicts/army/analysis-defense-and-security-industry/analysis-myanmar-fighters-use-home-made-uav-to-bomb-junta-forces

Caldwell, M., Andrews, J. T. A., Tanay, T., & Griffin, L. D. (2020). AI-enabled future crime. *Crime Science*, *9*(14), 1–13. https://doi.org/10.1186/s40163-020-00123-8

Dolata, M., & Schwabe, G. (2023). Moving beyond privacy and airspace safety: Guidelines for just drones in policing. *Government Information Quarterly*, *40*(4), 101874. https://doi.org/10.1016/j.giq.2023.101874

Duma, L. A., Begonia, M. T., Miller, B., & Duma, S. M. (2021). Proposed injury threshold for drone blade lacerations. *Annals of Biomedical Engineering*, *49*(4), 1125–1127. https://doi.org/10.1007/s10439-021-02759-2

Gehl, R., & Plecas, D. (2017). *Introduction to criminal investigation: Processes, practices and thinking*. Justice Institute of British Columbia. https://pressbooks.bccampus.ca/criminalinvestigation

International Criminal Police Organization. (2020). *Framework for responding to a drone incident: For first responders and digital forensics practitioners*. INTERPOL Global Complex for Innovation. https://www.interpol.int/content/download/15298/file/DFL_DroneIncident_Final_EN.pdf

Jackman, A., & Hooper, L. (2023). *Drone incidents and misuse: Legal considerations*. University of Reading. https://research.reading.ac.uk/drone-geographies/wp-content/uploads/sites/271/2023/12/Drone-incidents_Jackman-Hooper.pdf

MacDermott, Á., Baker, T., Buck, P., Iqbal, F., & Shi, Q. (2020). The internet of things: Challenges and considerations for cybercrime investigations and digital forensics. *International Journal of Digital Crime and Forensics (IJDCF)*, *12*(1), 1–13. https://doi.org/10.4018/IJDCF.2020010101

Mercer, D. (2019, February 23). Revealed: Drones used for stalking and filming cash machines in the UK. Sky News. https://news.sky.com/story/police-warn-drone-users-after-incidents-soar-by-40-in-two-years-11637695

MGR Online. (2023, September 21). พม่าจับตาชายแดนไทยช่องทางส่งอาวุธ หลังเกิดเหตุ "โดรนทิ้งระเบิดสังหารผู้ว่าฯ เมียวดี" [Myanmar monitors Thai border as weapon smuggling route following drone bombing that killed Myawaddy governor]. https://mgronline.com/indochina/detail/9660000085247 [in Thai]

National Forensic Science Technology Center. (2013). *Crime scene investigation: A guide for law enforcement.* U.S. Department of Justice, Bureau of Justice Assistance. https://www.nist.gov/system/files/documents/forensics/Crime-Scene-Investigation.pdf

National Institute of Justice. (2023, June 2). *Addressing contraband in prisons and jails as the threat of drone deliveries grows.* https://nij.ojp.gov/library/publications/addressing-contraband-prisons-and-jails-threat-drone-deliveries-grows

Ngamkham, W. (2017, September 25). CIB tackles illegal drone flight threat. Bangkok Post. https://www.bangkokpost.com/life/tech/1330587/cib-tackles-illegal-drone-flight-threat

Peck, G. (2023, September 4). A drone attack on Myanmar border police reportedly kills 5. A resistance group claims responsibility. AP News. https://apnews.com/article/myanmar-drone-attack-resistance-army-5b33181347a355fc24091f6570ee9329

Reiber, L. (2018, December 21). Scene of the crime: You've found a drone. What do you do?. Forensic Focus. https://www.forensicfocus.com/articles/scene-of-the-crime-youve-found-a-drone-what-do-you-do

Rogers, J., & Kunertova, D. (2022). *The vulnerabilities of the drone age: Established threats and emerging issues out to 2035.* Center for War Studies. https://css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/NATO_VDA_Policy_Report.pdf

Roolak, S. (2017). แนวทางการควบคุมอากาศยานไร้คนขับของหน่วยขึ้นตรงของกระทรวงกลาโหมและเหล่าทัพ [Guidelines for the control of unmanned aerial vehicles for subordinate units of the Ministry of Defence and the Armed Forces]. [Individual study, Royal Thai Army War College]. http://www.awc.ac.th/storage/research/100.pdf [in Thai]

Rosati, A. & Bronner, E. (2018). Inside the coup plotting before the Venezuela drone assassination attempt. Bloomberg. https://www.bloomberg.com/news/articles/2018-08-17/two-coup-plotting-groups-met-weeks-before-venezuela-drone-attack

Rosenblatt, K. (2016, June 25). Canadian woman, 38, is hit on the head by a drone after it fell out of the sky while filming a 5k event in Quebec. *DailyMail*. https://www.dailymail.co.uk/news/article-3659980/Canadian-woman-38-hit-head-nearly-3-pound-drone-device-fell-sky-filming-5k-Quebec.html

Sayler, K. (2015). *A world of proliferated drones: A technology primer*. Center for a New American Security. https://www.jstor.org/stable/resrep06394

Singh, I. (2022, October 7). How a DJI Mini drone enabled a $147,000 ATM robbery. *DroneDJ*. https://dronedj.com/2022/10/07/dji-mini-drone-atm-theft

ThaiPBS. (2023, April 9). *ปะทะเดือด! ทหาร-อส.ถูกปิดล้อมขว้างไปป์บอมบ์-ยิง M-79 ถล่ม* [Intense clash! Soldiers and volunteer defence corps trapped, bombarded with pipe bombs and M-79 grenades]. https://www.thaipbs.or.th/news/content/326455 [in Thai]

The Civil Aviation Authority of Thailand. (2022). *รูปแบบคู่มือปฏิบัติการบินของอากาศยานซึ่งไม่มีนักบิน* [Operations manual template for unmanned aircraft operations]. https://uasportal.caat.or.th/docs/guidanceFlight/CAAT-GM-UAS-001.pdf [in Thai]

The Guardian. (2015, April 22). *Drone 'containing radiation' lands on roof of Japanese PM's office*. https://www.theguardian.com/world/2015/apr/22/drone-with-radiation-sign-lands-on-roof-of-japanese-prime-ministers-office

Tolba, K. (2023, August 22). Emirates A380 wing damaged after drone collision in France. Aviation Business Middle East. https://www.aviationbusinessme.com/airlines/emirates-a380-drone

Unmanned Airspace. (2023, January 23). *DroneSec reports 60% increase in drone incidents in 2022 compared with 2021*. https://www.unmannedairspace.info/latest-news-and-information/dronesec-reports-60-increase-in-drone-incidents-in-2022-compared-with-2021

Valdovinos, M., Specht, J., & Zeunik, J. (2016). *Community policing and unmanned aircraft systems (UAS): Guidelines to enhance community trust*. Office of Community Oriented Policing Services. https://www.policinginstitute.org/publication/community-policing-unmanned-aircraft-systems-uas-guidelines-to-enhance-community-trust

Wattanarung, A. (2019). *การกำหนดความรับผิดทางอาญาจากการละเมิดความเป็นส่วนตัวโดยใช้อากาศยานไร้คนขับ* [Criminal liabilities of privacy violation by unmanned aircraft vehicle] [Master's thesis, Chulalongkorn University]. https://digital.car.chula.ac.th/chulaetd/9300 [in Thai]

Yaacoub, J. P., Noura, H., Salman, O., & Chehab, A. (2020). Security analysis of drones systems: Attacks, limitations, and recommendations. *Internet of Things*, *11*, 100218. https://doi.org/10.1016/j.iot.2020.100218

Zanelli, E. & Bödecker. H. (2024). *Global drone market report 2023–2030*. Drone Industry Insights. https://droneii.com/product/drone-market-report