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The anatomy of enforcement: a comparative analysis of waste crime investigations

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Abstract

Waste crime—including illegal dumping, trafficking, and improper waste management—poses serious risks to environmental sustainability and public health. Despite its links to organized and financial crime, investigative practices remain under-researched. This study addresses this gap by analysing twenty judicial cases from Australia, Canada, Ireland, and the UK. Through comparative content analysis, the research identifies key investigative practices, recurring challenges, and inter-jurisdictional differences. While forensic sampling and site inspections are common, approaches to proactive policing and multi-agency coordination vary. Limited resources, delayed enforcement, and weak transnational cooperation further hinder effectiveness. The study underscores the value of intelligence-led strategies and proactive investigation tools in disrupting waste crimes. It also highlights the untapped potential of technologies such as drones and satellite imagery in improving evidence collection. By identifying best practices and procedural gaps, the study contributes to the development of more effective, standardized, and collaborative approaches to investigating waste crime globally.

Introduction

Waste crime is a specific subset of environmental crime that often includes the illegal trafficking, disposal, and treatment of waste (Tompson and Chainey 2011; Baird et al. 2014; Andreatta et al. 2023). These waste crimes account for a large portion of environmental crime and are an increasing challenge to governments across the globe (Environment Agency 2021; UNODC 2023).

Illegal waste dumping, treatment, and trafficking can cause significant environmental and human harm and constitute a lucrative sector for organized criminal networks (Massari and Monzini 2004; Favarin and Thachuk 2022). The release of hazardous materials into soil, water, and air damages ecosystems and reduces biodiversity and generates severe and lasting health risks, including respiratory disease, cancers, and developmental disorders. These impacts are often concentrated in communities located near disposal or transit sites, amplifying existing social and environmental inequalities. The significance of waste crime lies in this dual burden: it degrades natural environments while imposing long-term health costs on populations least able to bear them.

The low risk of detection and prosecution additionally makes these waste crimes especially appealing to criminal networks (Morganti et al. 2020). Enforcement responses are often weak, hindered by limited inter-agency cooperation, lack of resources, and low political prioritization (Lynch et al. 2016; Faroque and South 2022; Favarin and Meneghini 2024). Investigative teams are typically under-funded and understaffed, and cross-agency cooperation is rare compared to other crimes like drug trafficking (EUROJUST 2014; Faroque and South 2022). Ambiguities in environmental legislation and underdeveloped procedures further obstruct effective prosecution (Morganti et al. 2020).

This paper focuses on the challenges surrounding investigation and evidence gathering in waste crime cases—specifically illegal waste dumping, waste trafficking, and the unlawful operation of a waste facility—within domestic contexts. Understanding how these investigation procedures work is essential for equipping investigators with the tools to effectively identify and prosecute offenders so that environmental law can be enforced. Improved clarity and alignment in investigative frameworks can foster international cooperation and enhance the deterrent effect of policing waste crime (Lynch et al. 2019; Andreatta and Favarin 2020; Faroque and South 2022; Mulatu and Yigzaw 2024).

Literature review

Research on the specific procedures used by police to investigate waste crimes is almost nonexistent. Most studies have focused on the challenges of investigation and prosecution,

rather than the procedural steps and best practices for investigations (Billet and Rousseau 2014; Billet et al. 2014; Blondiau et al. 2015; Lynch et al. 2016; Lynch 2022). This contrasts with other crime types, where investigative methods have been widely studied—particularly in drug trafficking, domestic violence, burglary, robbery, and homicide (Brandl and Frank 1994; Antrobus and Pilotto 2016; Berlusconi et al. 2016; Saxton et al. 2020; Aziani and Persurich 2023).

For drug trafficking, research looks at where police should invest resources in investigations (Bright et al. 2015) and how to improve investigation techniques (Berlusconi et al. 2016). For domestic violence, police investigation research has focused on how investigation practices can affect the safety of victims and the recidivism of the offender (Mayhill 2019; Belknap and Grant 2021). Furthermore, research has strongly criticized mandating arrests in police responses to domestic violence incidents, outlining complex situations and the impact of arrests on children (Elliffe and Holt 2019; Saxton et al. 2020). A substantial empirical literature has researched how to improve police investigations of burglary and robbery (Eck 1983; Brandl and Frank 1994; Fox and Farrington 2015; Antrobus and Pilotto 2016; Coupe 2016; Sherman and Strang 2017). Research has provided empirical evidence that detective effort can significantly contribute to solving burglaries, especially when little suspect information is available, underscoring the importance of sustained investigative persistence (Brandl and Frank 1994). For homicide, researchers have looked at how factors related to police investigations (Braga and Dusseault 2018), police investigation resourcing (Braga et al. 2019), and police discretion (Aziani and Persurich 2023), can improve homicide clearance rates. As these examples show, the investigation procedures of several crimes have received extensive scholarly attention, leading to improvements in how police investigations impact successful prosecutions.

In contrast, studies on waste crime rarely address police investigations directly. Forensic studies have explored innovative techniques for identifying, characterizing, and assessing the nature and quantity of waste. Consequently, these studies have *indirectly* shed light on the investigative processes (Lega and Teta 2016; Di Fiore et al. 2017; Alderuccio et al. 2019; Mager and Blass 2022). Building on collaborative efforts among the University of Naples, LEAs, and the Regional Agency for Environmental Protection, several advanced applications of drones and satellites for detecting and determining the origin of waste crime were tested (Lega et al. 2014; Lega and Teta 2016; Di Fiore et al. 2017; Mager and Blass 2022). These studies underscored the practicality of leveraging technology to detect waste crime and trace its origins in investigations. Additionally, Alderuccio et al. (2019) aimed to construct a forensic method for establishing the link between waste operators and illicit waste. While this study offered insights into a specific forensic procedure for a particular waste crime, it also highlighted the complexities involved in investigating them. From an investigative perspective, forensic research has contributed to an understanding of the willingness of LEAs to adopt new technology in waste crime investigations (Di Fiore et al. 2017; Casazza et al. 2018). However, there remains a scarcity of research exploring the entire investigation process of waste crimes. Consequently, there is a need for research that delves into the intricacies of waste crime investigations, encompassing the broader criminological dimensions involved.

Research on waste crime prosecution further supports the need for improved investigative practices, often cited as a primary barrier to successful cases (Lynch et al. 2016, 2019; Lynch 2022). These studies have revealed that waste crimes are prosecuted at lower rates compared to other forms of criminal activity, despite their significant harms (Ozymy and Jarrell 2015; Lynch et al. 2016). This research argues that investigation efforts often fall short of the evidentiary standards and coordination required for the scale and complexity of many waste crimes (Billet and Rousseau 2014; Billet et al. 2014; Blondiau et al. 2015; Lynch et al. 2019; Lynch 2022). They also argue that one of the main reasons waste crimes are under prosecuted is the lack of resources and effort dedicated to developing comprehensive investigation procedures that account for their complexity (Faroque and South 2022; Mulatu and Yigzaw 2024).

Problem formulation

Despite its significance, there is a striking lack of empirical research on the investigative procedures used by LEAs to combat waste crime. Investigative practices specific to waste crime remain largely underexplored, limiting the development of evidence-based policing strategies and hindering both national and international cooperation—an essential element given the complex, often transnational, and highly specialized nature of these crimes.

Waste crimes such as waste trafficking frequently cross borders and involve multiple jurisdictions, requiring coordinated international responses. As such, understanding how waste crime investigations are carried out cannot be limited to a single jurisdiction. Investigative approaches vary among countries, shaped by differences in legal frameworks, LEA structures, and regulatory oversight. Comparing approaches is crucial for fostering stronger international collaboration, harmonizing investigative practices, and improving the overall effectiveness of waste crime enforcement.

To address this research gap, this study aims to analyse and compare the investigative techniques used by police to combat waste crime across multiple jurisdictions. To meet this aim, we employ two primary research questions:

1. What are the main features of police investigations into waste crime?
2. How do police investigations into waste crime vary across countries?

The first question seeks to identify the core characteristics of investigative practices, helping to assess the strengths and limitations of current approaches. The second focuses on cross-national variation, recognizing that waste crime often transcends borders and regulatory systems. Together, these

questions provide insight into the investigative process and support the development of best practices at both national and international levels.

Data and methodology

This study employs a content analysis of 20 judicial criminal cases to systematically examine investigative procedures across different jurisdictions.[1] By analysing case law, this research identifies patterns, strategies, and procedural challenges in waste crime investigations. A comparative approach was adopted to highlight investigative variations across jurisdictions, offering insights into how different enforcement frameworks shape case outcomes.

This study's methodological approach builds on criminological research techniques used in studies on police responses to domestic violence, and prosecutorial strategies in waste crime cases (Belfrage et al. 2012; Levi 2013; Runhovde 2016; Saxton et al. 2022). In line with Platt's (1981) principles of documentary analysis, this study systematically scrutinized judicial documents, focusing on investigative processes. A structured coding scheme was applied to identify commonalities and discrepancies in how waste crime investigations unfold across the different cases and jurisdictions.

Data collection

The collection of judicial cases for analysis was guided by three main methodological criteria: (1) similarity between legal frameworks; (2) accessibility of documents through open sources; (3) language accessibility. To ensure consistency, we selected only case law from common law systems. Because common law systems rely on judicial precedent, focusing on these jurisdictions minimizes legal discrepancies that could complicate comparative analysis. Only cases available through open-access legal databases were included, ensuring transparency, verifiability, and replicability. Language accessibility was also essential. As common law jurisdictions are primarily English-speaking, focusing on one language allowed for more efficient and accurate comparison. This approach supports a structured, practical evaluation of investigative patterns using comprehensive, widely available judicial sources.

Judicial cases were sourced from the following databases: the Australian Legal Information Institute (AUSTLII), Canadian Legal Information Institute (CANLII), British and Irish Legal Information Institute (BAILII), the UK National Archives, the Court Service of Ireland, and the UNODC's SHERLOC database (Sharing Electronic Resources and Laws on Crime). Each database provides open access to historical case law archives in English.[2]

Search criteria

A rigorous search methodology was used to identify relevant case law with precision and accuracy. The goal was to collect judicial documents related to waste crimes, particularly dumping, trafficking, and illegal management. Boolean operators and keyword strategies were used in each database. For example, AUSTLII searches combined terms like 'waste dumping', 'waste trafficking', 'waste management', and 'waste crime'. Related terms such as 'illegal disposal' were also used to capture variations in terminology.

Each result was reviewed to determine whether it addressed at least one of the selected waste crime categories or fell outside scope (e.g. civil disputes). In addition, many cases lacked sufficient information about police investigative procedures. Cases that did not focus on the investigative aspect, such as appeals or those limited to procedural matters, were excluded. Cases that were older than twenty years were not included—as these were not considered to be representative of current practice. This filtering process, which took all search results on the legal institute databases, then selected the more recent and relevant cases, ensured that the final dataset included cases offering meaningful insight into investigative practices across jurisdictions, forming a solid foundation for comparative analysis.

Sample description

Table 1 provides an overview of the resulting sample of cases, outlining the year of the case, jurisdiction, type of waste crime, and the source. The sample encompasses 20 cases, spanning four jurisdictions—Australia, Canada, the UK, and Ireland. The offences involved hazardous materials (e.g. asbestos and electronics) alongside routine household or construction waste, illustrating varied environmental and public health risks. Together, these cases provide a robust foundation for understanding investigation and procedural structures in addressing waste crime.

Methodological framework for investigative comparison

An Investigative Comparison Framework was developed to systematically analyse and compare investigative techniques across jurisdictions. The framework is based on four key investigative phases: suspicion of criminal activity, preliminary assessment, formal investigation, and notice of compliance/prosecution. These phases offer a consistent basis for assessing and comparing investigative practices across cases.

[1] Supplementary Annex 1 contains the complete list of all judicial documents used in the analysis, accompanied by a brief description and full citations for each case law, including information on where they can be accessed.

[2] AUSTLII, CANLII, and BAILII are part of the broader 'Free Access to Law Movement,' which promotes free and open access to legal information for citizens. AUSTLII is hosted by the University of Technology Sydney. BAILII, inspired by AUSTLII, is jointly hosted by the University of London and University College Cork. CANLII is maintained by the Federation of Law Societies of Canada. These three nonprofit platforms provide free access to case law and legislation and are key legal resources in their respective countries. Additional official sources were also used, including the UK National Archives and the Court Service of Ireland. The UK National Archives collect and publish government documents, while the Court Service of Ireland manages court administration and public access to case law. Finally, SHERLOC is an online portal hosted by the UNODC, designed to support access to legal information related to the UN Convention against Transnational Organized Crime. Although fewer cases are available on this platform, they tend to involve more serious offences.

Table 1 Sample description of the judicial cases analysed[a].

Name of case	Year	Jurisdiction	Type of waste crime	Source
AUS1	2015	Australia	Waste Trafficking and Dumping	AUSTLII
AUS2	2018	Australia	Unlawful Operation of a Waste Facility	AUSTLII
AUS3	2021	Australia	Waste Dumping	AUSTLII
AUS4	2020	Australia	Unlawful Operation of a Waste Facility	AUSTLII
AUS5	2018	Australia	Unlawful Operation of a Waste Facility	AUSTLII
CAN1	2012	Canada	Waste Dumping	CANLII
CAN2	2002	Canada	Waste Dumping	CANLII
CAN3	2012	Canada	Unlawful Operation of a Waste Facility	CANLII
CAN4	2008	Canada	Waste Dumping	CANLII
CAN5	2023	Canada	Waste Dumping	CANLII
GBR1	2012	UK	Waste Trafficking	SHERLOC
GBR2	2018	UK	Waste Trafficking	The National Archives (UK)
GBR3	2008	UK	Waste Dumping	BAILII
GBR4	2014	UK	Waste Trafficking and Dumping	BAILII
GBR5	2010	UK	Waste Dumping	BAILII
IRL1	2015	Ireland	Unlawful Operation of a Waste Facility	The Court Service of Ireland
IRL2	2021	Ireland	Waste Dumping	The Court Service of Ireland
IRL3	2013	Ireland	Waste Dumping	The Court Service of Ireland
IRL4	2023	Ireland	Waste Dumping	The Court Service of Ireland
IRL5	2018	Ireland	Waste Dumping	BAILII

[a]Supplementary Appendix S1 contains a description and full citations for each case law presented in Table 1. Direct links to access the judicial cases are also provided in the Supplementary Appendix.

Table 2 Investigative comparison framework.

Investigative phase	Description	Guiding questions
Suspicion of criminal activity	This refers to when enforcement agencies are made aware of potential criminal activity that requires investigation.	How did the police become aware of the illicit activity? How was it brought to their attention?
Preliminary assessment	This refers to the preliminary, immediate, and resource efficient checks that enforcement agencies undertake in order to corroborate the potential criminal activity.	Did police undertake a preliminary check? How long did this take? What methods did they use in the preliminary investigation?
Formal investigation	This refers to the process of undertaking an in-depth criminal investigation aimed at collecting evidence for potential prosecution.	Was there a period of time between preliminary check, a warning, and then the formal investigation? When did they start a formal investigation? What methods did they use in this investigation? What was the timeline of the investigation?
Notice of compliance/ prosecution	This refers to the communication that enforcement agencies have with the investigated subjects, to either notify them of the investigation, as a cease-and-desist warning, or as notice of intent to prosecute.	Did the investigating authorities issue a warning? Did this warning produce problems in the investigation later on?

A set of guiding questions was developed to extract key details about each phase. These questions serve as analytical tools to ensure comprehensive documentation and capture all critical procedural elements. Table 2 presents the investigation phases, their descriptions, and the corresponding guiding questions.

Results

Australia

Across the five Australian cases, offences were largely uncovered through proactive enforcement rather than passive complaints. In AUS1, the EPA opened an investigation after a public report, then used site inspections, sampling, and document checks to show that 'clean fill' consignments dumped on rural properties contained asbestos and other contaminants. In AUS2 and AUS5, targeted field operations and surveillance of waste movements revealed unlicensed waste facilities and subsequent sampling and records audits established breaches of recovery-exemption conditions and contamination. In AUS4, scheduled compliance inspections identified an unlicensed depot receiving mixed construction and demolition waste, triggering prosecution. AUS3 was distinct: following PFAS-contaminated water incidents, the EPA focused on incident response and later cost recovery for reasonable clean-up actions rather than uncovering concealed dumping.

All five cases included a swift preliminary phase involving unannounced inspections (AUS1, AUS4), covert monitoring (AUS2), or truck surveillance (AUS5). During these preliminary visits, investigators often took photographs, noted the volumes of waste, and conducted sampling (AUS1, AUS3). Some preliminary phases were longer than others: AUS1's preliminary inquiry spanned just under a week, whereas AUS2's covert operations extended over half a year.

Warnings frequently emerged in the Australian cases after the preliminary phase. In AUS1, the EPA's first visit gave the operator a tacit warning that they were under scrutiny. Even though a formal written notice was not delivered, arriving on-site, taking photographs, and sampling instead served as an informal warning. Upon return, officers discovered that certain waste piles had been moved, suggesting an attempt to hide illicit waste before a second inspection. This incident highlights how quickly a perpetrator might react if they sense heightened enforcement interest, effectively complicating the chain of evidence.

All cases progressed to formal investigation once the offence was confirmed. This phase involved sampling (soil, asbestos, and chemicals) and photographic documentation. A recurring strength was a layered approach: combining inspections, forensic sampling, and licence verification. Timelines varied: AUS1 ran from late 2011 to mid-2013; AUS2 lasted eight months; AUS3 extended from 2015 to 2020. AUS5 involved six months of surveillance, and AUS4 took over a year from initial letters to definitive Environment Protection Orders.

Overall, authorities exhibited a structured escalation model—public or staff awareness, site inspections, warnings/notices, extended surveillance, and then formal evidence collection and enforcement. The strengths of the Australian context were robust sampling and inter-agency cooperation, and the weaknesses were potential evidence tampering once perpetrators realized they were under scrutiny.

Canada

The five Canadian cases show that authorities uncovered waste and environmental offences through both reactive and proactive means. In CAN1 and CAN2, citizen reports about fire risks and suspicious dumping triggered swift responses by local authorities, leading to inspections, sampling, and enforcement. CAN3 and CAN4 stemmed from proactive oversight, where routine compliance checks revealed permitting breaches and unlawful works in or around a watercourse. CAN5 reflects sustained regulatory monitoring: a multi-year, multi-agency investigation combining site inspections, laboratory analysis, and permit-file review to document mine-site discharges and reporting failures.

Preliminary investigations involved initial site visits and basic inquiries. In CAN1, the district Fire Chief and later the Ministry of Environment (MOE) visually inspected tank contents and collected samples. CAN3 included simple on-site checks to confirm unauthorized debris, while CAN4 began with a conservation officer photographing a gravel intrusion in a creek. CAN5 featured file reviews (permit cross-checks) and a subsequent helicopter visit. Common approaches across cases included observing alleged dump locations, sampling suspect material, taking photographs, and verifying or denying permit existence.

Warnings varied in timing and significance. CAN1 indicated that once the Fire Chief and MOE realized a tanker held PCB-laden waste,[3] they directed the operator not to accept more waste. CAN2 did not detail a separate warning before the RCMP or environmental officers' response. CAN3 and CAN4 each had warnings to guide compliance, and these notices did not disrupt evidence collection like in Australia. CAN5 recorded a caution to the site manager mid-inspection, which did not hinder sampling or subsequent interviews.

Formal investigations began after preliminary confirmation of offences. CAN1 escalated after PCB detection; CAN2 involved immediate RCMP–EPA coordination. CAN3 escalated after repeated permit violations; CAN4 and CAN5 followed similar patterns upon identifying illegal activity. Formal phases included site visits, sample collection, operator interviews, and permit analysis. Investigations spanned months. In CAN1, the process ran from September to December 2008. CAN2 unfolded across May–June 2000. CAN3 stretched over 2005–2006, CAN4 covered April–June 2008, and CAN5 progressed swiftly in July 2015.

Canadian investigations were strong in prompt inspections, systematic sampling, and multi-agency collaboration. However, delayed escalation (e.g. CAN3) and the absence of clear warnings in some cases hindered effectiveness. While coordination and thorough evidence-gathering generally improved outcomes, gaps between early checks and prosecution occasionally emerged.

Ireland

The Irish cases show that waste crimes were uncovered through a blend of community complaints and proactive

[3]Polychlorinated biphenyls (PCBs) are highly toxic industrial chemicals that were widely used in electrical equipment, hydraulic systems, and various industrial applications. They were eventually banned in many countries due to their severe environmental and health hazards. PCB waste is classified as hazardous due to its persistence, bio accumulative nature, and toxicity.

inspections, often followed by layered enforcement. IRL1 arose from over 1,400 odour complaints around a licensed landfill, leading to EPA inspections and prosecutions for licence breaches. IRL2 began with a tip about dumping on farmland; inspections, sampling, drone surveys, and joint operations with An Garda Síochána later confirmed hazardous stockpiles threatening a local water supply. IRL3 started with an anonymous report of landfill-type activity, where follow-up assessments revealed over 1,000 tonnes of mixed waste and led to High Court and Supreme Court action. IRL4 was triggered by routine inspections that uncovered two large unregulated landfills, later rated high risk and subject to repeated court orders and contempt proceedings. IRL5 stemmed from council-led checks into long-running unauthorized waste operations, pursued through High Court enforcement and appeal. Together, these cases highlight the central role of both citizen reporting and regulatory vigilance in detecting serious waste offences.

Preliminary checks followed soon after authorities became aware. IRL1 entailed multiple EPA site visits focusing on odour intensity, while IRL2 involved direct inspections and sampling by council staff. IRL3 featured two months of site visits and environmental analyses, and in IRL4, the EPA undertook a risk assessment to confirm unlicensed materials on farmland. IRL5 involved local authority inspections and, later, District Court warrants for more in-depth sampling. Key preliminary methods in all five cases included visual observations, photography, soil or waste sampling, and consultant-led environmental evaluations.

Warnings or notices were served once officials corroborated initial findings. In IRL1, this involved repeated noncompliance notices (warnings) on odour levels. IRL2 likewise saw lawful directions issued well before a full search warrant was obtained. In IRL3, ignoring the council's official requests eventually led to a High Court order. In IRL4, lawful directives were followed by an extensive risk assessment. In IRL5, a series of warnings and High Court orders culminated in contempt proceedings.

Formal investigations typically started once early checks confirmed potential contraventions. During formal phases, councils relied on repeated site visits (IRL1), specialized sampling (soil, water, landfill gas), (IRL5), aerial, or drone surveys, lab analyses, and legal instruments (injunctions, lawful directives, and contempt applications) (IRL2, IRL4). Investigations usually lasted from 2–5 years overall, owing to repeated noncompliance or adjournments (IRL2, IRL3, and IRL5).

A clear strength was systematic sampling and court-driven enforcement, supplemented by consistent documentation of breaches. Weaknesses included protracted delays between initial discovery and final court action, sometimes allowing further dumping. Nonetheless, these five Irish cases consistently illustrated how local authorities, upon receiving complaints or performing checks, escalated methodically from preliminary site visits and warnings to formal investigation and eventual High Court remedies.

The UK

The British cases illustrate how waste crime is typically detected through port inspections, proactive regulator checks, and public intelligence. GBR1 involved the Environment Agency (EA) intercepting containers at ports, where misdescribed exports of hazardous waste to West Africa were discovered through inspections and shipping-record analysis. GBR2 followed similar port checks, with containers labelled as 'paper' found to contain nappies, plastics and food waste, confirming illegal export under EU shipment rules. GBR3 stemmed from local authority and EA inquiries into repeated fly-tipping, leading to conspiracy charges. GBR4 arose from regulator site visits that documented large-scale waste operations on farmland without permits, with prosecutions testing how knowingly permitting and waste are legally defined. GBR5 also began with EA container inspections, though the prosecution was later discontinued. Across the set, the cases show the EA's reliance on routine monitoring, targeted port operations, and legal clarification to address both domestic dumping and international waste trafficking.

Preliminary checks consisted of site or container inspections, photographing, and lab tests. GBR1 featured port interceptions and tracker evidence. GBR2 involved physical container examinations, identifying extensive contamination (nappies, rotting meat, etc.). GBR3's preliminary investigation included covert visits to multiple fly-tipping sites. GBR4 involved local site visits. GBR5 began with a parish council complaint, followed by official property inspections. These preliminary inquiries took days to weeks, depending on the urgency of complaints or shipping deadlines.

Warnings or official cautions were not always emphasized. GBR1 and GBR2 did not involve warnings prior to formal enforcement. Instead, the border guard seized containers and proceeded with evidence-gathering. In GBR3, the appellant was interviewed by the police, which acted as an indirect warning. GBR4 similarly had no warning, beyond the Environment Agency's communications. GBR5 likewise indicated no official or unofficial warning.

Formal investigations generally started once preliminary findings confirmed unlicensed or hazardous waste. GBR1 and GBR2 escalated to full inquiries after container checks revealed suspect waste cargo. GBR3 and GBR5 intensified enforcement once repeated site observations validated large-scale unauthorized activity. GBR4 moved to a formal stage after the EPA determined no valid permit existed at the site. Throughout these formal inquiries, authorities employed repeated inspections, sampling, photographs, and coordination with customs or other agencies. GBR1 and GBR2 involved container searches and bills of lading checks. GBR3 emphasized financial tracing (linking a fictitious name to the defendants), while GBR4 relied on follow-up visits and lawful orders to secure records. Investigations spanned from roughly 1–3 years.

Overall, strengths in the UK's approach included meticulous container or site inspections, sample analyses, and multiagency coordination. Weaknesses arose around timing and possible delayed escalation in some cases (e.g. GBR3 continued months after the first police interview) and the absence of a clear warning phase.

Cross-country comparison

Overall, the cases from Australia, Canada, Ireland, and the UK highlight both similarities and differences in detecting,

investigating, and prosecuting waste crimes. They illustrate core procedures while revealing the complexity of such investigations—multiple agencies, varied laws, and long timelines.

Australia showed more proactive oversight, with routine EPA checks (AUS4) and targeted operations (AUS2, AUS5) prompting detection. Canada balanced reactive and proactive approaches: CAN1 and CAN2 stemmed from citizen complaints, while CAN3 arose from permit checks. Ireland relied heavily on public reports (IRL1, IRL2), though IRL4 included a structured risk assessment. The UK combined proactive port checks (GBR1, GBR2) with reactive responses to local complaints (GBR3, GBR5).

All jurisdictions conducted preliminary investigations. Australia often acted quickly—AUS1 took under a week; AUS2 spanned six months. CAN2 was addressed within a day, while CAN3 took over a year. UK container cases were swift; dumping cases were slower. Ireland ranged from rapid checks (IRL2) to delays following extended complaints (IRL1). These differences reflect how case complexity shapes timelines.

Agency coordination also varied. Australia demonstrated strong inter-agency cooperation among the EPA, expert consultants, and state agencies (AUS1); and Canada's multi-agency responses were especially effective (CAN2). Ireland's reliance on local councils limited coordination. In the UK, the Environment Agency, customs, and NGOs (GBR1) worked closely on port cases, though a lack of formal warnings in some cases caused issues. Investigation timelines ranged widely: 1–2 years in Australia, a few months to over a year in Canada, 2–5 years in Ireland, and up to 5 years in the UK for site-based cases. These reflect differing enforcement strategies, with faster administrative responses in Canada and court-led enforcement in Ireland.

Common strengths included site sampling, documentation, and legal instruments. Canada and Ireland showed strong multi-agency work. Australia stood out for proactive intelligence, Canada for aerial monitoring, and the UK for regulatory controls. All countries successfully escalated from suspicion to formal investigation through multi-pronged approaches. Recurring challenges included delays—due to prolonged observation or legal adjournments (in Ireland)—and evidence tampering, as in AUS1. In the UK, the absence of formal warnings complicated enforcement (GBR1, GBR2). In sum, while jurisdictions differ in approach, all require inter-agency cooperation, forensic tools, and procedural rigour to navigate the complexity of waste crime enforcement. Strengthening investigative frameworks will be essential to improve responses globally.

Discussion

Proactive policing in waste crime enforcement

Waste crimes often occur without a clearly identifiable victim, making them harder to detect and more likely to go unnoticed. As a result, reactive approaches—where law enforcement responds to citizen reports—are often inadequate. Our analysis confirms that this reactive model remains predominant across jurisdictions. However, criminological research provides strong evidence that proactive policing is highly effective in preventing crime before harm occurs (Weisburd and Majimundar 2018; Wu et al. 2022).

Strategies such as hot spots policing, predictive analytics, and surveillance have proven effective in reducing street crime but remain underused in waste crime contexts. One exception is the UK, where intelligence-led policing was successfully applied to track illegal waste exports (Gibbs et al. 2015). In these cases, targeted, data-informed operations were coordinated across agencies, bypassing slower reactive processes.

A key advantage of proactive policing in environmental contexts is the ability to intervene early using regulatory tools before harm escalates. Measures like permit suspensions, administrative fines, and unannounced inspections allow for immediate enforcement—avoiding the delays of criminal prosecution. This is particularly crucial in waste crime, where even brief delays can cause irreversible damage.

Our case analysis shows that Australia and Canada made significant use of such measures. In Australia, environmental agencies employed covert surveillance and site inspections along transport routes. Canada used aerial monitoring, permit cross-checks, and rapid multi-agency responses. These examples illustrate how intelligence-led, proactive enforcement can greatly improve the speed and quality of investigations.

Multi-agency collaboration in waste crime enforcement

Waste crimes rarely occur in isolation—they are often connected to other offences, such as tax evasion, permit fraud, or document falsification. A coordinated approach is therefore essential. Multi-agency collaboration enables police, environmental regulators, local authorities, customs, and forensic specialists to address waste-crime networks from multiple angles and has proven effective in dismantling local criminal networks in the UK (Barrett and White 2017). Our cases show this mix in practice: regulator-led investigations with forensic sampling and documentary audits in AUS1–AUS2, public-officer prosecutions supported by site surveillance and volumetric assessments in AUS4–AUS5, port-side interdictions by the Environment Agency coupled with documentary checks in GBR1 and GBR2, land-based inspections and 'knowingly permitting' prosecutions in GBR3 and GBR4, coordinated same-day attendance by a municipal fire chief, labour officials, and environmental regulators with laboratory analysis in CAN1, and council-police-consultant teams using drone mapping, warrants, and risk assessments to secure injunctions and remediation in IRL and IRL4.

Collaboration allows for shared information, technical expertise, and complementary enforcement powers; it turns community intelligence and routine oversight into admissible scientific evidence and enforceable orders. At the same time, inter-agency work is not without challenges: clear protocols and defined roles are needed to avoid delays where warrants, site access, or emergency containment must be coordinated, gaps that can arise when local councils operate without strong links to police or national environmental authorities, as seen in parts of the Irish set. Internationally, fragmented systems, limited data-sharing, and data-protection constraints can

further hinder cooperation (Gibbs et al. 2015; Pink and White 2016). Despite these barriers, cross-border and cross-agency intelligence sharing remains vital for transnational waste trafficking, often involving illicit exports from the Global North to the Global South, making joint enforcement protocols and shared investigative frameworks a priority (Favarin and Aziani 2020; Favarin et al. 2023).

Waste crime as financial crime

As previously discussed, waste crimes often intersect with a range of other offences, including tax evasion, fraud, and financial misconduct. At their core, these crimes are primarily driven by economic incentives. Businesses or entrepreneurial actors may engage in illegal dumping or trafficking as a deliberate cost-saving strategy, exploiting regulatory loopholes to avoid the expenses associated with lawful waste disposal (Baird et al. 2014; Andreatta and Favarin 2020). Understanding the financial motivations behind them is therefore essential for effective enforcement.

Investigations must therefore include financial analysis—such as reviewing bank records, auditing corporate finances, and tracing beneficial ownership. In one UK case, this approach uncovered a complex fly-tipping operation hidden behind fictitious companies and dubious transactions. Financial tracing exposed the profit structure and enabled prosecution not only of the offenders but also those financing the crime.

Recent research confirms that both internal firm characteristics—such as size, age, and financial distress—and external factors like market volatility and disposal costs influence the likelihood of illegal activity (Troisi et al. 2024). These findings support the view that waste crime often reflects rational economic decision-making by firms under pressure, and that company-specific traits can be used as indicators of potential illegal behaviour.

Framing waste crime as a financial crime allows for the use of enforcement tools traditionally associated with white-collar crime: asset freezes, tax audits, permit revocations, and anti-money laundering investigations (Riccardi 2014; Riccardi et al. 2016, 2018). Targeting the financial infrastructure behind environmental offences strengthens deterrence by imposing economic, not just legal, consequences.

Forensic evidence and emerging technologies in waste crime detection

Forensic evidence—especially soil, water, and material sampling—was central in all analysed cases. Alongside photographic documentation and site inspections, these methods allowed law enforcement agencies to establish the presence, nature, and extent of illegal waste activities, often under contested conditions.

Emerging technologies, including GPS tracking, satellite imagery, and drone surveillance, are increasingly enhancing investigative practices. These tools improve precision, speed, and access to remote or otherwise difficult locations. In the UK, investigators embedded a GPS tracker in a discarded television destined for domestic recycling. The tracker revealed its illegal export to Nigeria, providing real-time, irrefutable evidence of a transboundary waste crime—illustrating the utility of geolocation tools (Lee et al. 2018).

Drones proved especially useful in Ireland, where they were used to survey suspected illegal landfills. Authorities employed drones to measure waste volumes, document unauthorized dumping, and support risk assessments by external consultants. Their use helped reduce evidence-gathering time and improve the accuracy of environmental evaluations.

Although advanced sensing and surveillance technologies have clear potential, they remain underused across many jurisdictions and under-examined in criminology. Targeted investment in scalable platforms—such as remote-sensing systems (Lega et al. 2014; Alderuccio et al. 2019; Singh 2019; Mager and Blass 2022), thermal imaging, and AI-driven video analytics—could enhance evidence collection, shorten investigations, and support proactive, cross-border enforcement. Embedding these tools in standard doctrine, training programmes, and interoperable data systems would close intelligence gaps and shift policing from a reactive model to intelligence-led deterrence.

Methodological constraints and limits

While this study offers important insights into investigative approaches across jurisdictions, two primary methodological constraints should be acknowledged. These do not undermine the findings but clarify the scope within which they should be interpreted.

First, the sample is limited to common law nations and judicial cases resulting in written rulings. This may introduce selection bias towards more structured or successful prosecutions, omitting informal settlements or failed cases. However, the objective was to examine formal investigative practices, and judicial rulings remain among the most reliable sources for this. Inclusion was restricted to cases with substantive details on investigation processes.

Second, while judicial documents were our primary data source, they do not always provide full insight into operational dynamics or informal decision-making. Some investigative actions may be summarized or omitted. To mitigate this, a structured coding framework was used to extract and compare all available details. This ensured consistency in analysis, even when narrative depth varied between cases.

Conclusion

This study provides one of the first comparative, empirically grounded analyses of police investigations into waste crime. By examining judicial cases across Australia, Canada, Ireland, and the UK, it identifies shared investigative strengths—such as thorough forensic sampling and multi-agency collaboration, while also exposing weaknesses, including enforcement delays, fragmented intelligence sharing, and inconsistent use of warnings. The findings demonstrate that procedural differences and operational gaps limit the effectiveness of enforcement, particularly in cases requiring rapid intervention or transnational coordination.

Importantly, the study shows that jurisdictions that adopted proactive policing and intelligence-led methods, particularly

Australia and Canada, achieved more efficient and timely investigations. It also highlights the value of forensic evidence and emerging technologies, such as drone surveillance and satellite imagery, which remain underutilized in many waste crime investigations. In addition, the study emphasizes the importance of adopting a proactive and financial crime perspective in waste crime enforcement. Although financial scrutiny was infrequent in the cases analysed, it proved to be a promising avenue. Framing waste crime as economically motivated enables the use of financial tracing, asset recovery, and regulatory sanctions—tools that can meaningfully disrupt the profit structures of environmental offenders. To strengthen enforcement globally, there is a pressing need for harmonized investigative protocols, expanded use of remote sensing technologies, and institutionalized multi-agency frameworks. Without such reforms, waste crime will remain an attractive, low-risk activity for criminal actors.

Author contributions

This work is the result of the joint efforts of the two authors, who discussed and reviewed the manuscript together. Both P.S. and S.F. conceptualized and jointly wrote the results, discussion, and conclusion sections. P.S. developed the methodology and managed the data collection and formal analyses. S.F. composed the literature review and theoretical framework.

Supplementary material

Supplementary material is available at *Policing* online.

Conflicts of interest

The authors report there are no competing interests to declare.

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