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Strengthening the Early Detection Capability of CBRN Crimes to Improve National Security

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Abstract

The threat of Chemical, Biological, Radiological and Nuclear (CBRN) crimes is increasingly complex and has the potential to disrupt the stability of Indonesia's domestic security. This study aims to analyse efforts to strengthen early detection capabilities against CBRN crimes to improve national security. The method used is a qualitative approach with descriptive-analytical method, supported by literature study and SWOT analysis. The results show that although Indonesia has supporting institutions and regulations, such as

BAPETEN, BRIN, as well as Law No. 10 of 1997 and Presidential Instruction No. 4 of 2019, cross-sector coordination is still weak and there is no leading sector that regulates the handling of CBRN threats in an integrated manner. Several real cases such as the use of radioactive materials by terrorist groups in Bandung 2017 and the delivery of envelopes containing anthrax in Jakarta 2019 emphasise the urgency of strengthening the early detection system. The SWOT analysis recommends policy priorities in the form of establishing a national coordinating institution, increasing human resource capacity and detection technology, developing integrated protocols, and strengthening international cooperation. With strategic and collaborative steps, Indonesia can build a CBRN early detection system that is resilient and responsive in facing future threat dynamics.

Keywords

CBRN, Early Detection, Interagency Collaboration, National Security

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I. Introduction

National security is one of the important aspects that needs to be maintained by every country. Chemical, Biological, Radiological and Nuclear (CBRN) crimes are one of the serious threats that can disrupt the stability and security of a country. CBRN crimes not only cause casualties, but also long-term impacts on health, the environment, and the economy. Therefore, it is important to strengthen early detection capabilities against foreign-born crimes in order to improve domestic security. Indonesia, with its strategic geographical position, high biological diversity, and

complex socio-political dynamics, is in a vulnerable position to the threat of CBRN. This risk is exacerbated by technological advances and easy access to hazardous materials, which can be misused by negative actors, such as terrorist groups, criminal organisations, and even individuals with radical tendencies[1].

Global experience shows that CBRN attacks, while rare, can have a very damaging impact. History has recorded several incidents, such as the sarin gas attack in Tokyo in 1995 and the anthrax attacks in the United States in 2001, which highlight the importance of effective early detection systems. The threat of CBRN does not only come from terrorist groups but can also arise from accidents in industrial facilities or laboratories that handle hazardous materials [2]. Likewise, with the domestic situation, the existence of six attempted terror attacks using Chemical, Biological, Radiological, and Nuclear (CBRN) materials during the 2011-2019 period, shows a significant urgency in strengthening the early detection capability of CBRN crimes in Indonesia. Incidents such as the use of arsenic and ricin poison at the Kemayoran Police Station in 2011, the nitroglycerin bomb in Solo in 2012, the chlorine gas bomb attack at ITC Depok in 2015, as well as the use of radioactive materials from light bulb shirts containing thorium by terrorist groups in Antapani, Bandung in 2017, show the variety and complexity of the CBRN threats faced [3].

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[1] Detmar W. Straub and Richard J. Welke, "Coping with Systems Risk: Security Planning Models for Management Decision Making," *MIS Quarterly: Management Information Systems* 22, no. 4 (1998): 441–64, https://doi.org/10.2307/249551.

[2] Federico Benolli, Matteo Guidotti, and Fabio Bisogni, "The CBRN Threat. Perspective of an Interagency Response," *Advanced Sciences and Technologies for Security Applications*, 2021, 429–48, https://doi.org/10.1007/978-3-030-42523-4_29.

[3] Yohanes Genius putu Sanjaya, A. J. S. Runturambi, and Sidratahta Mukhtar, "STRATEGI PENCEGAHAN SERANGAN TERORIS DI INDONESIAMENGGUNAKAN WEAPONS MASS DESTRUCTION (WMD) OLEH POLRI,BNPT, BAPETEN, TNI, BNPB DAN

Furthermore, incidents in 2019 such as the use of nitroglycerin bombs in Bogor, the discovery of abrin poison in Cirebon, bomb attacks in Surabaya using TATP (Tri Acetone Triperoxide), and the delivery of envelopes containing anthrax bacteria to the French embassy in Jakarta, underline the shift in tactics used by terrorist groups [4]. From the use of conventional bombs, they shifted to the use of CBRN materials that have the potential as weapons of mass destruction if used on a larger scale. Since 2001, Indonesia's Ministry of Industry (KEMENPERIN) has only identified and declared a total of 35 industrial facilities classified as BKODN (Non Listed Discrete Organic Chemicals). These chemicals can be used as precursors for the manufacture of chemical weapons, representing a potentially high risk to national security. This condition emphasises the need for a stricter supervision and control system over the distribution and use of these hazardous chemicals to prevent their misuse in acts of terrorism, especially those related to the manufacture of chemical weapons.

The global landscape of Chemical, Biological, Radiological and Nuclear (CBRN) threats is undergoing significant transformation driven by three factors: technological advances that accelerate the production and deployment of dangerous weapons, easier access to CBRN materials, and increased capabilities of state and non-state actors in exploiting security gaps[5]. In this context, early detection mechanisms become a critical foundation for

KEMENPERIN," *Journal of Terrorism Studies* 2, no. 1 (May 20, 2020), https://doi.org/10.7454/JTS.V2I1.1020.

[4] The Jakarta Post, "Bogor Terrorism Suspect 30th Arrested in May Alone - National - The Jakarta Post," The Jakarta Post, 2019, https://www.thejakartapost.com/news/2019/05/17/bogor-terrorism-suspect-30th-arrested-in-may-alone.html.

[5] Gregory D. Koblentz, "Emerging Technologies and the Future of CBRN Terrorism," *The Washington Quarterly* 43, no. 2 (April 2, 2020): 177–96, https://doi.org/10.1080/0163660X.2020.1770969.

national security, as CBRN threats have the potential to trigger massive damage in a short time. Countries, including Indonesia, must develop anticipatory strategies to identify and neutralise these threats before they develop into a crisis. This urgency is especially important for a nation with complex geography and rich biodiversity that is vulnerable to misuse, such as the spread of biological pathogens. In addition, the country's dynamic socio-political conditions may increase the risk of conflict, while rapid industrialisation raises the potential for chemical and radiological hazards[6]. The combination of these factors makes Indonesia vulnerable to unconventional CBRN threats that require a multidime security approach.

The use of chemicals as homemade explosives in acts of terrorism has become part of the modus operandi of terrorist groups in various parts of the world, including Indonesia[7]. This adds to the complexity of the threat faced, considering that these materials are often easy to obtain and convert into weapons with high destructive power. This phenomenon indicates that terrorist groups continue to innovate and improve their capabilities in using CBRN materials to create fear, panic and wider destruction. This shift creates greater challenges for security and law enforcement agencies in detecting and preventing such attacks before they occur.

The use of chemicals as improvised explosive devices (IEDs) by terrorist groups is an increasingly common and dangerous tactic around the world, including in Indonesia. The primary reason

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[6] Mega Agustina, Rika Wijiyanti, and Teddy Mantoro, "Integration of Government Regulations to Anticipate the Threat of Terrorism with Radioactive and Nuclear Technology," *2022 IEEE 8th International Conference on Computing, Engineering and Design, ICCED 2022*, 2022, https://doi.org/10.1109/ICCED56140.2022.10010339.

[7] David Royds, "A Ten Year Retrospective of the Bombing Campaign in Indonesia by Terrorists, 2002–2006," *Australian Journal of Forensic Sciences* 45, no. 2 (June 1, 2013): 123–46, https://doi.org/10.1080/00450618.2012.733027.

behind the popularity of this method is the accessibility and dual-use nature of its basic components[8]. Materials such as ammonium nitrate (commonly used as fertiliser), acetone (nail polish remover), hydrogen peroxide (antiseptic), and potassium chlorate are often legally available on the market for industrial, agricultural, or household purposes[9]. The ease of obtaining these precursors allows terrorist groups with limited resources to produce high-explosive weapons independently in makeshift laboratories or 'kitchen' bomb-making facilities. This phenomenon significantly lowers the threshold for terrorist cells to plan and carry out attacks, as they no longer rely on military-grade explosives that are difficult to obtain and strictly monitored.

In Indonesia, the history of terrorist attacks has shown a strong reliance on homemade chemical explosives. The most tragic example is the 2002 Bali Bombing, where the perpetrators used a mixture of potassium chlorate, aluminium powder, and sulphur as the main components of a massive car bomb that killed over 200 people[10]. Subsequent attacks, including the bombings at the JW Marriott and Ritz-Carlton hotels in 2009, also relied on IEDs made from similar materials. Local terrorist groups have proven to have the knowledge and capability to formulate various types of explosives, one of which is Triacetone Triperoxide (TATP), a highly unstable and powerful compound known as the 'Mother of

[8] Johannes Rath, Monique Ischi, and Dana Perkins, "Evolution of Different Dual-Use Concepts in International and National Law and Its Implications on Research Ethics and Governance," *Science and Engineering Ethics* 20, no. 3 (February 5, 2014): 769–90, https://doi.org/10.1007/S11948-014-9519-Y/METRICS.

[9] Gareth Collett et al., "The Use of a Predictive Threat Analysis to Propose Revisions to Existing Risk Assessments for Precursor Chemicals Used in the Manufacture of Home-Made Explosives (HME)," *Heliyon* 7, no. 12 (December 1, 2021), https://doi.org/10.1016/j.heliyon.2021.e08343.

[10] David Royds, Simon W. Lewis, and Amelia M. Taylor, "A Case Study in Forensic Chemistry: The Bali Bombings," *Talanta* 67, no. 2 (August 15, 2005): 262–68, https://doi.org/10.1016/J.TALANTA.2005.03.026.

Satan'[11]. The ability to produce TATP from easily accessible household chemicals indicates the transfer of knowledge and tactical innovation within the global terrorist network that has been adopted by local cells[12].

The shift towards the use of chemical explosives is part of the strategic evolution of terrorist groups towards the exploitation of CBRN (Chemical, Biological, Radiological, and Nuclear) threats. While large-scale nuclear or biological attacks are still considered technically challenging, the use of chemicals as explosives is a tangible and proven effective step within this spectrum of threats. The primary objective of such attacks is not only to cause physical damage and casualties but also to maximise psychological impact. Attacks using IEDs create widespread terror and panic, erode public confidence in the state's ability to ensure security, and dominate media coverage. Thus, chemical explosives have become an efficient 'weapon of choice' for achieving the strategic objectives of terrorism, namely spreading fear and disrupting socio-political stability.

The threat of improvised chemical weapons (Chemical IEDs) poses a major challenge for security forces and law enforcement agencies. Monitoring dual-use chemicals is far more complicated than monitoring conventional weapons. Therefore, strong cross-sector cooperation is essential, involving the police, intelligence agencies, the Ministry of Trade, and the chemical industry. The objective is clear: to monitor the supply chain and detect unusual

[11] Kirk Yeager, "Improvised Explosives Characteristics, Detection, and Analysis," *Forensic Investigation of Explosions, Second Edition*, January 1, 2011, 493–538, https://doi.org/10.1201/B11938-18/IMPROVISED-EXPLOSIVES-CHARACTERISTICS-DETECTION-ANALYSIS-KIRK-YEAGER.

[12] Rueben Ananthan Santhana Dass, "Jihadists' Use and Pursuit of Weapons of Mass Destruction: A Comparative Study of Al-Qaeda and Islamic State's Chemical, Biological, Radiological and Nuclear (CBRN) Weapons Programs," *Studies in Conflict and Terrorism* 47, no. 5 (2024): 548–82, https://doi.org/10.1080/1057610X.2021.1981203.

purchases. Additionally, forensic capabilities must be enhanced. We need to be able to analyse post-explosion residues to trace the origin of the chemicals used. Prevention efforts must also involve the public, through awareness campaigns and encouraging chemical sellers to report suspicious activities. In essence, addressing this threat requires an adaptive, proactive, and intelligence-based counter-terrorism strategy. The goal is to thwart terrorist preparations before an attack can occur.

Not only the chemical threats discussed earlier, but another aspect of the CBRN spectrum that demands high vigilance is the biological threat. The COVID-19 pandemic has served as a stark reminder of how vulnerable every country is to biological security threats. This experience has clearly opened our eyes to how biological agents, which have the potential to be misused as weapons, can spread rapidly and widely, causing massive damage on a global scale. Biological security, as an integral part of the CBRN framework, now requires special attention in early detection and security response strategies to ensure a country's capability to identify and respond to biological threats as quickly as possible before escalation occurs.

Given the complexity and dynamics of CBRN threats as a whole, including the potential use of chemical and biological agents by non-state actors such as terrorist groups, collaborative efforts are absolutely necessary to integrate resources and competencies from various agencies and sectors. This includes developing advanced early detection capabilities for various types of agents, building robust and adaptive security infrastructure to address various threat scenarios, and training and developing high-quality human resources with specific expertise in addressing CBRN threats. Cross-sectoral and international collaboration is key to building a comprehensive and responsive defence system against the evolution of these threats.

These capabilities are not only limited to technical aspects such as improved detection technologies and sophisticated intelligence systems, but also include non-technical aspects such as improved inter-agency cooperation, personnel training and public awareness of potential CBRN threats [13].One of the significant challenges in strengthening the early detection capability of CBRN crimes in Indonesia is the absence of a clear leading sector in CBRN security [14]. Likewise, coordination and integration between relevant sectors, including health, industry, defence and law enforcement, still need to be strengthened. National awareness and preparedness for the threat of CBRN must be continuously improved, ensuring that Indonesia is able to respond effectively and efficiently to potential threats that may arise in the future [15].

Early detection of extraterritorial crimes requires a multidisciplinary approach that integrates advanced technology, accurate intelligence and inter-agency cooperation, both at the national and international levels [16]. This includes the development

[13] X. Hu, H. Chen, and M. Yu, "Exploring the Non-Technical Competencies for on-Scene Public Health Responders in Chemical, Biological, Radiological, and Nuclear Emergencies: A Qualitative Study," *Public Health* 183 (June 1, 2020): 23–29, https://doi.org/10.1016/J.PUHE.2020.04.015.

[14] Zora A. Sukabdi, "Bridging the Gap: Contributions of Academics and National Security Practitioners to Counterterrorism in Indonesia," *International Journal of Law, Crime and Justice* 65 (June 1, 2021): 100467, https://doi.org/10.1016/J.IJLCJ.2021.100467.

[15] R.A. Nora Lelyana, S. Pantja Jati, and Willy Arafah, "Effective Strategic Planning and Knowledge Management Effects on Organizational Performance Mediated by Dynamic Capability Towards Threats of Chemical, Biological, Radiology, and Nuclear (CBRN) Weapon," September 15, 2020, 252–56, https://doi.org/10.2991/AEBMR.K.200915.058.

[16] Tim J. Wilson, "Criminal Justice and Global Public Goods: The Prüm Forensic Biometric Cooperation Model," *Journal of Criminal Law* 80, no. 5 (October 1, 2016): 303–26, https://doi.org/10.1177/0022018316668450;WGROUP:STRING:PUBLICATION.

of capabilities to monitor, identify and evaluate risks related to crimes of violence. In improving early detection systems, a key consideration is how to integrate data and information from various sources, including field detection, security intelligence, and laboratory monitoring, to provide a clear and accurate picture of potential threats [17]. Detection technology should be able to identify hazardous materials quickly and accurately, enabling relevant authorities to take preventive or response measures before escalation occurs.

In addition, human factors also play a critical role in the early detection process. Adequate training for personnel involved in the management and response to a CBRN incident is essential [18]. Personnel must have the necessary knowledge and skills to operate detection equipment, conduct risk analyses, and execute response protocols effectively. At the national level, the strengthening of policy and regulatory frameworks related to the management of CBRN materials, as well as increased collaboration between government agencies, the private sector and international organisations, are key to the detection and response of CBRN crimes [19]. This includes increased information sharing, joint training, and research and development in CBRN detection and mitigation technologies.

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[17] A. S. Albahri et al., "A Systematic Review of Trustworthy and Explainable Artificial Intelligence in Healthcare: Assessment of Quality, Bias Risk, and Data Fusion," *Information Fusion* 96 (August 1, 2023): 156–91, https://doi.org/10.1016/J.INFFUS.2023.03.008.

[18] Saeed Nazari et al., "Structural Elements and Requirements in Forming Prehospital Health Response Teams in Response to Chemical, Biological, Radiation, and Nuclear Incidents (CBRN), a Comparative Review Study," *Disaster Medicine and Public Health Preparedness* 17, no. 9 (February 14, 2023): e300, https://doi.org/10.1017/DMP.2022.259.

[19] Jozef Sabol et al., "Current Activities of the European Union in Fighting CBRN Terrorism Worldwide," *NATO Science for Peace and Security Series B: Physics and Biophysics* 74 (2015): 157–67, https://doi.org/10.1007/978-94-017-9894-5_15.

A number of previous studies have addressed CBRN (Chemical, Biological, Radiological, and Nuclear) risk management mainly in the context of developed countries. Benolli and his colleagues explain that interagency coordination in Europe has successfully improved CBRN threat mitigation efforts through structured collaboration between government, military, and civilian agencies [20]. Nazari and his team highlight the importance of the role of pre-hospital medical teams in responding to CBRN emergencies, by comparing various international strategies to refine emergency handling systems[21]. Meanwhile, Sabol and his colleagues analyse the European Union's unified policy in dealing with the threat of CBRN terrorism, and emphasise that regulatory harmonisation is an important factor in prevention efforts [22]. Blatny discussed how biological threats are being used in the form of hybrid warfare, pointing out that state and non-state actors are increasingly utilising dual-use technologies to create chaos [23] . On the other hand, Bowsher saw biosecurity as an important part of global defence, and proposed the need for international standard protocols to address evolving biological risks [24].

In Indonesia, Sukabdi criticised the national readiness in dealing with CBRN threats. He highlighted the weak implementation of policies, as well as the lack of synergy between

[20] Benolli, Guidotti, and Bisogni, "The CBRN Threat. Perspective of an Interagency Response."
[21] Nazari et al., "Structural Elements and Requirements in Forming Prehospital Health Response Teams in Response to Chemical, Biological, Radiation, and Nuclear Incidents (CBRN), a Comparative Review Study."
[22] Sabol et al., "Current Activities of the European Union in Fighting CBRN Terrorism Worldwide."
[23] J. M. Blatny, "Biological Threats," *Advanced Sciences and Technologies for Security Applications*, 2022, 47–78, https://doi.org/10.1007/978-3-031-17374-5_3.
[24] Gemma Bowsher, "A Multifaceted Threat," *Essentials of Biological Security: A Global Perspective*, March 1, 2024, 31–41, https://doi.org/10.1002/9781394189045.CH3.

academic research and concrete actions from the government [25]. While these studies provide many lessons from developed countries on how to manage CBRN risks, the main focus still revolves around responses after an incident occurs or on systems that work in countries with established infrastructure. This creates an important gap in the literature, which is the lack of discussion on proactive and contextualised early detection systems - systems designed specifically for developing countries like Indonesia. Indonesia faces different challenges, such as its archipelagic geography, complex and abuse-prone ecosystems, and volatile socio-political dynamics.

However, these studies often prioritize post-incident response or focus on mature regulatory environments, thereby overlooking the conditions in low- and middle-income countries, where systems are still evolving. There is limited research that addresses early-stage detection policies within developing country contexts like Indonesia—particularly studies that evaluate not only policy readiness, but also cross-sectoral integration and legal-regulatory alignment. Strengthening early detection capabilities of CBRN crimes is a strategic priority for enhancing national security. It is not only about dealing with existing threats, but also preparing for potential new threats that continue to evolve in an uncertain global environment [26]. Understanding and addressing these challenges requires a comprehensive approach, encompassing technology, policy, and cooperation between sectors and countries.

This paper addresses these gaps through a multi-faceted approach that combines doctrinal legal analysis, SWOT-based

[25] Sukabdi, "Bridging the Gap: Contributions of Academics and National Security Practitioners to Counterterrorism in Indonesia."

[26] Marjolijn Haasnoot et al., "Dynamic Adaptive Policy Pathways: A Method for Crafting Robust Decisions for a Deeply Uncertain World," *Global Environmental Change* 23, no. 2 (April 1, 2013): 485–98, https://doi.org/10.1016/J.GLOENVCHA.2012.12.006; Straub and Welke, "Coping with Systems Risk: Security Planning Models for Management Decision Making."

policy evaluation, and comparative study of international best practices. The novelty of this research lies in its localization of globally acknowledged frameworks such as BioWatch and the UK's Resilience Programme into a culturally and institutionally relevant model for Indonesia. The study does not merely catalogue weaknesses; it formulates actionable pathways through which Indonesia can transition from a reactive to a proactive national security paradigm. With the rising frequency and sophistication of CBRN threats, particularly in Southeast Asia, the findings of this study are both timely and critical. The intended outcome is not just academic enrichment, but the formulation of robust, implementable recommendations for national policy and interagency governance.

II. Method

The writing of this paper uses a qualitative approach with a descriptive-analytical method, which aims to explore in depth the dynamics and complexity of strengthening early detection system capabilities against the threat of CBRN (Chemical, Biological, Radiological, and Nuclear) crimes in the context of homeland security. The choice of this approach is based on the consideration that the characteristics of the phenomenon studied are multidimensional and require a holistic contextual understanding.

The data collection process was conducted through library research, which included a systematic review of academic literature, national and international policy documents, indexed scientific journals, as well as relevant regulations and legislation. In order to support the situation analysis and identification of strategic issues, this research applied SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis as an analytical instrument to evaluate the internal and external conditions of the CBRN early detection system in Indonesia. The use of SWOT analysis is

positioned as the initial stage in the process of evidence-based strategy formulation.

Furthermore, this research integrates various theoretical perspectives to strengthen the analytical foundation, including strategic management theory, national security theory, organisational theory, and inter-agency collaboration theory. This integrative approach is intended to produce strategic recommendations that are not only conceptual, but also implementative in order to strengthen the CBRN early detection system that is sustainable, synergistic, and responsive to contemporary threat dynamics. Figure 1 represents the research workflow diagram.

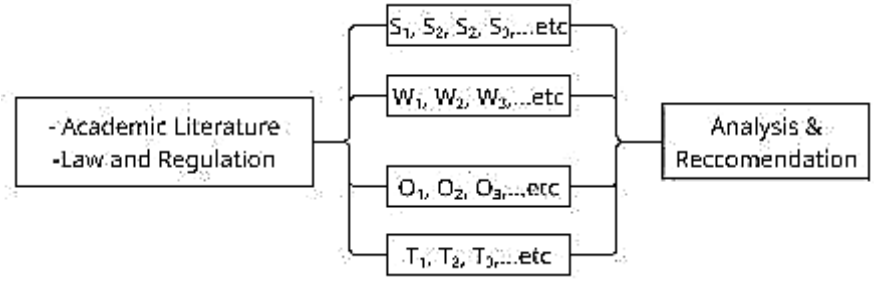

Figure 1. Research Workflow

III. Result & Discussion

A. Identification of Problems in the Early Detection System of CBRN Crimes in Indonesia

Based on the literature review and document analysis related to strengthening the early detection capability of CBRN crimes in Indonesia, several important facts were found:

1. Absence of Leading Sector

   Although Indonesia has enacted several foundational regulations related to CBRN safety such as Law No. 10 of 1997

on Nuclear Energy and Presidential Instruction No. 4 of 2019 there is no designated national agency responsible for the coordination of early detection efforts. This institutional vacuum has led to fragmented responsibilities among agencies such as the Indonesian National Police (Polri), BAPETEN, the Indonesian National Armed Forces (TNI), and BRIN. The absence of a lead coordinating body results in inefficient inter-agency collaboration, lack of unified protocols, and weak accountability. This finding suggests a critical governance gap that hinders the development of a comprehensive national early warning framework.

2. Weak Detection Capacity

   The capacity for early detection is significantly constrained by the uneven distribution of advanced detection technology and trained personnel across regions. While several institutions possess CBRN-related capabilities, they are heavily concentrated in major urban areas. Remote and high-risk regions remain underserved, leaving large parts of the country vulnerable to unmonitored threats. The study finds that this disparity reflects a centralistic and risk-blind resource allocation model. Without decentralized investment in training and equipment, Indonesia's detection architecture will remain structurally inadequate to respond to geographically dispersed threats. The limited number of trained human resources and sophisticated CBRN detection equipment, especially in non-metropolitan areas, is one of the main obstacles. Some institutions such as Polri, BAPETEN, TNI, and BRIN have capabilities, but they are not evenly distributed.

3. Real Cases of Early Detection Failure

   There are several cases that show the weakness of the early detection system, among others:

a. Antapani case, Bandung (2017): A terrorist group used radioactive thorium extracted from commercial light bulbs. The fact that this material could be obtained and weaponized undetected underscores the deficiencies in monitoring and controlling domestic sources of radiological materials.
b. ITC Depok case (2015): A chlorine gas-based bomb was detonated in a public mall, revealing the lack of environmental chemical monitoring systems and insufficient local emergency preparedness.
c. Anthrax envelope case (2012): A letter containing anthrax spores was delivered to the French Embassy in Jakarta without prior detection, demonstrating vulnerabilities in the national postal system and the absence of biological hazard screening protocols.

These cases reveal more than just operational lapses; they point to fundamental design flaws in Indonesia's early detection strategy. The study argues that the underlying issues include the lack of predictive intelligence capabilities, the absence of integrated monitoring systems across sectors, and insufficient coordination between health, security, and intelligence agencies. Unless these systemic weaknesses are addressed through structural reforms and intersectoral policy integration, Indonesia's ability to detect and respond to CBRN threats will remain largely reactive and ineffective.

A key issue in Indonesia's CBRN crime detection system is the lack of a single agency in charge. In emergencies, a unified command is crucial for quick and coordinated action. Currently, responsibility is split across several institutions, causing overlaps, policy gaps, and poor communication that delay effective response. By comparison, the United States established the Department of Homeland Security (DHS) and Chemical Facility Anti-Terrorism Standards (CFATS), which play a direct role in coordinating

CBRN threat management across agencies. This system enables integrated and rapid cross-sector responses, particularly in emergency situations[27].

The weakness in detection capacity is another crucial issue, as Indonesia still lacks advanced detection equipment and trained personnel to quickly and accurately detect chemical, biological, radiation, or nuclear compounds. There is a lack of internationally standardised training for medical personnel, search and rescue teams, or police in identifying exposure to CBRN substances. Yet, in the context of modern terrorism, the ability to detect contamination quickly is key to preventing the spread of broader impacts. The case in Japan involving the Sarin gas attack by Aum Shinrikyo 1995, demonstrates that delayed detection and lack of medical training led to confusion in responding, resulting in 19 deaths and over 6000 injured [28]. This case highlights the importance of detection readiness as a key element of mitigation.

Indonesia itself has experienced several real cases of early detection failures that should serve as a wake-up call for system improvements. The irregularity of these procedures highlights the weakness of detection mechanisms and risk communication protocols to the public. In contrast, the anthrax envelope case in the United States in 2001 triggered a massive mobilisation of the FBI, CDC, and USPS with strict protocols and national biological tracking. This response demonstrated that system readiness and detection speed significantly contributed to reducing public panic and limiting the impact.

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[27] Albert J Mauroni, "Naval Postgraduate School Homeland Security Affairs," no. 3 (2010), http://hdl.handle.net/10945/24991.

[28] N. Yanagisawa, H. Morita, and T. Nakajima, "Sarin Experiences in Japan: Acute Toxicity and Long-Term Effects," *Journal of the Neurological Sciences* 249, no. 1 (November 1, 2006): 76–85, https://doi.org/10.1016/J.JNS.2006.06.007.

B. Evaluation of National Capabilities in Early Detection of CBRN Crimes: Findings and Recommendations

The findings above indicate that the early detection system for CBRN (Chemical, Biological, Radiological and Nuclear) crimes in Indonesia is far from optimal. The absence of a leading sector leads to inefficiencies in handling, task sharing and information exchange. Compared to developed countries, Indonesia's approach is still reactive, not preventive. As an illustration, the United States through the BioWatch programme is able to detect the presence of biological agents early in public spaces through automatic sensors and rapid response systems. The UK has also implemented a CBRN Resilience Programme approach that brings together police, military and medical personnel preparedness in one integrated system.

1. Institutional Fragmentation and Lack of Operational Integration

   Multiple institutions such as BAPETEN, BRIN, Polri, and TNI possess sectoral mandates related to CBRN threats[29]. However, the absence of a unified command structure or lead coordinating body results in siloed operations. Each agency applies its own protocols and operates within isolated regulatory environments, which inhibits interoperability during emergencies. The author argues that this institutional disunity reflects a broader problem of policy inertia: although frameworks exist on paper, they are not supported by

[29] Zuhdi Batubara, "Peningkatan Kemampuan Korps Brimob Polri Dalam Bidang KBRN Untuk Menghadapi Ancaman Terorisme: Sebuah Pendekatan Dalam Mendukung OMSP," *Ranah Research : Journal of Multidisciplinary Research and Development* 6, no. 6 (October 29, 2024): 2873–84, https://doi.org/10.38035/RRJ.V6I6.1159.

enforceable mandates or cross-sector accountability mechanisms.

2. Limited Technological Infrastructure and Human Resource Capacity

   CBRN detection technologies such as biosensors, portable spectrometers, and AI-enhanced data analytics remain scarce, particularly outside of Jakarta and other major cities. This centralization of capability leads to vulnerability in peripheral areas. Furthermore, most personnel assigned to CBRN detection tasks receive inconsistent or minimal training[30]. The lack of a standardized national certification system for CBRN responders contributes to operational asymmetries. The author suggests that capacity development must be a central pillar of reform, requiring coordinated investment in training centers, mobile units, and simulation-based preparedness programs.

3. Absence of Predictive Intelligence and Risk-Based Surveillance

   Currently, CBRN threat detection in Indonesia is predominantly reactive. There are no national systems that integrate intelligence data, public health reports, and industrial hazard monitoring into a predictive risk assessment platform. Without data fusion and early warning analytics, national security agencies remain blind to emerging threats until physical incidents occur. This gap severely undermines the principles of anticipatory governance. The author recommends the creation of an integrated CBRN risk intelligence center, linking agencies through real-time surveillance and decision-support systems.

[30] I. D.K.K. Widana et al., "Knowledge and Attitudes of the BNPB Leaders towards Nuclear Disaster Threat in Indonesia: Expectation and Reality – ICDM 2020," *IOP Conference Series: Earth and Environmental Science* 708, no. 1 (April 1, 2021): 012062, https://doi.org/10.1088/1755-1315/708/1/012062.

To further refine the strategic direction of national preparedness, this study employs a SWOT analysis to systematically evaluate Indonesia's internal strengths and weaknesses, as well as the external opportunities and threats shaping its early detection landscape. This analytical framework provides a structured basis for formulating policy responses that are not only reactive but also anticipatory and sustainable.

TABLE 1. SWOT Analysis

Aspect	Analysis
Strengths	- Presence of relevant technical institutions: BAPETEN, BRIN, Polri, TNI, BNPB, etc. - Availability of initial regulations such as Law No. 10/1997 and Presidential Instruction No. 4/2019. - Experience in handling real CBRN incidents. - Awareness of the authorities on the threat of CBRN is starting to increase.
Weaknesses	- There is no national leading sector specialising in CBRN. - Lack of coordination and interoperability between institutions. - Limited human resources and uneven detection tools. - Absence of integrated SOPs across sectors. - Supervision of hazardous materials distribution is still weak.
Opportunities	- Development of detection technologies (sensors, AI, big data).

	- Potential for international cooperation (IAEA, WHO, Interpol, etc.). - Global support for bio-chemical security post-COVID-19. - Integration with digital security/intelligence systems.
Threats	- Increased ability of non-state actors to access CBRN materials. - Misuse of industrial/laboratory materials. - Indonesia's vast and hard-to-reach geographical area. - Non-traditional threats (food/water contamination). - Delay in detection due to limited tools and protocols.

The results of the SWOT analysis show that strengthening early detection capabilities requires not only equipment and technology, but also leadership, integration, and integrated training across sectors. From these results, the following are some of the things that can be prioritised:

1. Appointment of a national agency responsible for CBRN security

   The appointment of one national agency specifically responsible for handling CBRN threats is a fundamental step to ensure an effective and centralised coordination system. The CBRN threat has cross-sectoral characteristics, involving aspects of health, defence, environment, public security, and economy. Therefore, one institution with a clear legal mandate is needed to coordinate all aspects of CBRN risk management,

from prevention, detection, response, to post-incident recovery.

This agency should have the authority to design national policies, develop technical regulations, oversee the distribution and use of hazardous materials, and be the official liaison with international organisations such as the International Atomic Energy Agency, the Organisation for the Prohibition of Chemical Weapons, and the World Health Organisation. The agency should also be equipped with technical units, forensic laboratories, and a digitally integrated national monitoring system. In addition, the agency's role should include coordination between national and local institutions, ensuring policy implementation across all levels of government. With a national agency that focuses on CBRN issues, Indonesia will have a strong structure in dealing with potential non-conventional disasters as well as increasing its capacity in international cooperation and global security diplomacy.

2. Strengthening detection capacity through human resource training and deployment of state-of-the-art detection equipment

Early detection is key in dealing with CBRN threats as it prevents risk escalation and provides sufficient time for the response system to act. To achieve this, human resource capacity building is a priority, through intensive and continuous training for personnel from various agencies such as military, police, border officers, laboratory officers, and medical personnel. This training should include theoretical understanding, field simulations, as well as the use of modern detection equipment. On the other hand, the deployment of

sophisticated detection equipment should be done evenly, especially at strategic points such as airports, harbours, industrial estates, and critical state facilities.

The tools used must be able to detect various types of chemical, biological, radiation and nuclear materials, with a high level of sensitivity and fast response time. In addition, the detection system must be integrated in the national information network, so that monitoring results can be directly followed up by the relevant authorities. To support operational sustainability, equipment maintenance and technician capacity building should also be part of the long-term strategy. With a reliable detection system and trained human resources, potential CBRN threats can be managed more effectively and structurally.

3. Establishment of an integrated protocol and inter-agency coordination forum

CBRN threats cannot be handled sectorally because they are complex and involve many agencies. Therefore, an integrated protocol is needed that clearly regulates handling procedures from pre-crisis to post-crisis stages. This protocol must contain operational standards for handling CBRN incidents, such as detection systems, evacuation, area isolation, decontamination, medical services, investigation, and environmental restoration. Each agency involved needs to have its role explicitly defined in the protocol so that there is no overlap or vacuum of authority when an incident occurs. In addition, the establishment of an inter-agency coordination forum is essential for communication, joint planning, and regular evaluation of national preparedness.

This forum can also be a place to exchange information and experiences between agencies and strengthen collaboration between the central government, local governments and the private sector. The existence of integrated protocols and coordination forums will strengthen the integration of the national security system, increase the speed and effectiveness of responses, and build a culture of cooperation in dealing with cross-sector and cross-region threats.

4. Strengthening international cooperation for technical support, training, and global early warning systems.

   In the face of transboundary and global CBRN threats, strengthening international cooperation is a must. Indonesia needs to actively collaborate with partner organisations and countries to obtain technical support, training, and access to a global early warning system. This cooperation could include intelligence sharing, joint training, dispatch of experts, emergency logistics assistance, and utilisation of advanced detection technologies. International organisations such as the International Atomic Energy Agency, the Organisation for the Prohibition of Chemical Weapons and the World Health Organization provide a range of assistance and training programmes that Indonesia can leverage to improve national capacity. In addition, regional co-operation is also important, for example through ASEAN or other regional mechanisms, to establish joint early warning systems, share best practices and conduct collective responses to large-scale CBRN incidents.

   Active participation in international agreements and regular reporting on non-proliferation obligations will also strengthen Indonesia's diplomatic position and build its image as a

responsible country in global security. By strengthening international cooperation, Indonesia will not only get direct benefits in the form of capacity building, but also contribute to the world's collective security system.

Strengthening early detection capabilities against Chemical, Biological, Radiological, and Nuclear (CBRN) threats is crucial for Indonesia's national security. As an archipelagic nation with high risks of disasters and misuse of hazardous materials, this approach cannot rely solely on technical aspects but also requires solid institutional governance.

The theory of Inter-Agency Governance emphasises the importance of cross-sector coordination, as CBRN issues cannot be handled by a single institution alone[31]. Through integrated cooperation between agencies an early detection system can operate more effectively through information sharing and swift, targeted responses. Meanwhile, the Adaptive Security Management approach promotes a flexible and responsive system to the dynamics of threats[32]. This approach emphasises the need for regular policy updates, routine evaluations, and data-driven preparedness based on threat scenarios.

The combination of these two approaches can strengthen Indonesia's early warning system. Inter-agency coordination creates operational synergy, while adaptive management allows for strategic adjustments to address evolving threats. As a result, these efforts not only enhance preparedness against CBRN crimes but

[31] Steven Curnin et al., "A Theoretical Framework for Negotiating the Path of Emergency Management Multi-Agency Coordination," *Applied Ergonomics* 47 (March 1, 2015): 300–307, https://doi.org/10.1016/J.APERGO.2014.10.014.
[32] Yan Chen, Xin (Robert) Luo, and Han Li, "Beyond Adaptive Security Coping Behaviors: Theory and Empirical Evidence," *Information & Management* 59, no. 2 (March 1, 2022): 103575, https://doi.org/10.1016/J.IM.2021.103575.

also strengthen national security resilience comprehensively. With the implementation of these measures, Indonesia can significantly improve its CBRN early detection capabilities, both to deal with the threat of terrorism and potential non-intentional incidents such as leakage of hazardous materials from industry.

IV. Conclusion

CBRN (Chemical, Biological, Radiological, Nuclear) threats are now a serious concern for our national security. Although Indonesia has institutional foundations and regulations in place, we cannot deny that there are significant gaps in early detection due to a lack of centralised leadership, weak coordination, and limited human resources and technology. However, we have great potential to strengthen this system by learning from advanced nations that prioritise clear leadership, advanced monitoring systems, and integrated training.

Therefore, it is time for us to develop an integrated national policy to drastically improve our early detection capabilities for CBRN crimes. This includes highly technical steps that we must take immediately:

1. Establishment of a National CBRN Coordination Agency: We need a clear national agency to serve as the main coordinator within the next two years if we look at the demands of global diplomatic instability. This agency must have a strong legal mandate and a mature organisational structure, with cross-ministerial representation.

2. Development of Human Resources and Detection Tools: This means standardising training curricula and tiered certification for CBRN responders across all institutions. Additionally, procuring advanced, calibrated multi-spectrum detection tools and establishing an integrated sensor network at critical locations are crucial.

3. Establishment of Integrated Cross-Sector Protocols: We must immediately develop specific national Standard Operating Procedures (SOPs) for various threat scenarios, supported by secure and interoperable communication systems. Full-scale joint exercises must also be conducted regularly to ensure smooth coordination.

4. Strengthening International Cooperation and Predictive Intelligence: It is important to establish comprehensive Memorandums of Understanding (MoUs) with international institutions such as the IAEA and WHO for cross-border early warning systems. Furthermore, we need to establish a CBRN predictive intelligence centre that leverages big data analysis and modelling to anticipate threats.

In essence, addressing CBRN threats requires a comprehensive, multidisciplinary, and collaborative approach. We can no longer be reactive; we must be proactive in anticipating future threats. With strong inter-agency collaboration and evidence-based policies, we can build a more

resilient national security architecture in the face of increasingly complex CBRN challenges.

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Publishing Ethical and Originality Statement

All authors declared that this work is original and has never been published in any form and in any media, nor is it under consideration for publication in any journal, and all sources cited in this work refer to the basic standards of scientific citation.