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The Threat of Biological Weapons and Bioterrorism to Indonesia's National Security: A Strategic, Legal, and Technical Overview

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ABSTRACT

The development of biotechnology in the era of Industrial Revolution 4.0 and Society 5.0 has opened up opportunities for the utilization of biological agents as non-conventional weapons. This research aims to analyze the potential threat of bioterrorism to Indonesia's national security, the classification of biological agents, as well as policy responses and national preparedness. The research methodology is qualitative-descriptive through literature studies from various primary and secondary sources. The study results show the high actual threat of bioterrorism due to the availability of biological agents, weak regulations, and inadequate response system readiness. This study recommends the drafting of the Bioterrorism Bill, increasing the capacity of Zeni Corps TNI AD and Brimob Polri especially Densus 88 & Gegana, and the readiness of national health infrastructure.

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INTRODUCTION

Biological weapons are unconventional threats that have a major impact on national stability and human security. Attacks such as the COVID-19 pandemic, while not classified as bioterrorism, show how a pathogen can paralyze state systems. Bioterrorism is defined as the deliberate use of biological agents such as viruses, bacteria, or toxins to spread disease or death (CDC, 2022). CBRNe non-conventional weapons that pose a potential threat to Indonesia are biological weapons. One proof of a biological weapon attack that has occurred is covid-19 which not only affects Indonesia, but has an impact on the whole world. Biological weapons are actually not only a serious threat to the Unitary State of the Republic of Indonesia, but a threat to all countries in the world.

In addition, one of the threats of terrorism both in Indonesia and the world is bioterrorism. Bioterrorism is the use of biological agents to create or spread certain diseases in a population or population that is targeted to achieve the desired goal of the terrorists, which is to create terror to the community (Farida, 2009). Bioterrorism attacks not only create tremendous panic and fear in humans but also have an impact on the survival of animals, plants and even the environment. The Centres for Disease Control and Prevention simply defines bioterrorism as: *"A biological attack, or bioterrorism, is the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops. Bacillus anthracis, the bacteria that causes anthrax, is one of the most likely agents to be used in a biological attack."*

From the definition put forward by the Centres for Disease Control and Prevention above, it can be understood that the crime of bioterrorism is a form of terrorism crime but by means of the deliberate release of viruses, bacteria, or other germs that can make sick or kill people, livestock, or plants. Bioterrorism is a term used to explain the use of sabotage or attack with biological materials or biological poisons with the aim of causing damage to individuals or groups of individuals or even a nation even within the scope of the State. With technological advances, of course bioterrorism crimes in the Era of the Industrial Revolution 4.0 will be increasingly dangerous, this is because in Era 4.0 sophisticated technology and tools have emerged so that they can be utilized in terrorism crimes using biological weapons or what is termed bioterrorism crimes.

LITERATURE REVIEW

Securitization Theory (Barry Buzan, Ole Wæver, and Jaap de Wilde)

Securitization Theory posits that issues become security concerns not simply because of their objective threat but because actors (often political elites) frame them as existential threats to a referent object (e.g., the state, society, or individuals). In the context of biological weapons and bioterrorism, this theory helps explain how Indonesia may classify biological threats as national security issues, justifying extraordinary policy responses such as emergency preparedness, military involvement, or legal changes. By labeling a biological event (like an engineered pathogen) as a national security threat, the state can mobilize resources and build institutional frameworks to address it moving the issue from the realm of normal politics to that of emergency politics.

Risk Society Theory (Ulrich Beck)

Beck's Risk Society Theory emphasizes that modern societies are increasingly preoccupied with the future and safety, particularly the risks generated by technological and scientific advancement. Biological weapons fall within these "manufactured risks," since their potential for catastrophic damage is linked to both technological misuse and governance failure. In Indonesia's case, the emergence of bio-threats underscores the state's dual responsibility: mitigating the probability of attack and managing the societal consequences should one occur. This theory highlights how Indonesia must balance technological innovation (e.g., in biotechnology and health security) with regulation, risk communication, and public trust. Together, these theories provide a strategic and sociopolitical lens to examine how biological threats are perceived, communicated, and managed within Indonesia's national security framework.

METHODOLOGY

This research methodology uses a literature review system by searching for journals and collecting data with keywords: Bioterrorism, CBRNE, Biological Weapons, National Security, SPARS, Preparedness, Pandemic. These sources are articles that have been published to Google Scholar. The bibliography of the article is obtained from several articles and books that are related to each other. The literature study method is an analysis of books, literature, records and reports that are relevant to the problem to be solved (Nazir, 2009). According to (Hasibuan & Zainal, 2007) literature review is a summary containing theories, findings, and other research sources obtained from references to be used as a basis for conducting research. This literature review utilizes a systematic literature review (SLR) approach that involves identifying, assessing and interpreting all findings related to the topic of discussion from various sources. A systematic review is a term used to refer to a particular research methodology, the development of which is to locate, collect and then evaluate research relating to a particular topic focus.

The stages of the SLR method are elaborated into 3 stages, namely: Planning, in writing refers to the problem formulation described in the introduction, the data used in this research is secondary data, secondary data can be obtained through literature studies, related scientific articles, implementation, the application of the SLR method can help find sources. At the stage of searching for reference sources or relevant literature using keywords, searching for journals that use English for international journals, while using Indonesian for national journals, reporting, the final stage in the SLR method where writing or analyzing the results that have been sought will be made in the form of writing which is then continued in the discussion of this literature review. This literature review analyzes and identifies articles related to the threat of biological weapons and bioterrorism, especially in the industrial 4.0 and social 5.0 era, which are filtered and summarized to introduce what biological weapons & bioterrorism are with their threats to the state. This article is also equipped with predictions of pandemics that will emerge in the future sourced from scientific journals. Articles

used in this review include theoretical studies and reviews that are considered relevant.

RESEARCH RESULT AND DISCUSSIONS

Biological Weapons & Bioterrorism

Bioterrorism is a terror threat that is very dangerous and difficult to detect so that it will have a major impact on the fulfillment of human rights, the regulation of bioterrorism crimes in Indonesia which has not been limiting further increases the chances of biological agent attacks that can occur at any time. With such rapid development, criminal law is increasingly being used and relied upon in order to regulate and order society through legislation (Prasetyo, 2010). This is because criminal law is a law that determines which actions should not be carried out, which are prohibited, accompanied by threats or sanctions in the form of certain punishments for those who violate these prohibitions (Moeljatno, 2008).

Bioterrorism that requires biological agents such as bacteria, viruses, parasites, fungi, and other biological microorganisms can be developed and genetically engineered to achieve more fatal damage than just bombing actions that require bomb sizes larger than vest bombs or sizes that can be carried by humans in general. These bioterrorism agents can be bred and engineered in biomedical laboratories by genetic engineers and experts in the field (Soeliongan, 2020). This is very dangerous because in the era of globalization, chemical and biological agents can be found easily by everyone through special trade channels and through the *dark web*.

Classification of Biological Agents according to CDC

The following Bio-agents that have been declared by the United States (US) Department of Health and Human Services or the US Department of Agriculture as having the potential to pose a serious threat to public health and safety are officially defined as "select agents." One of the classifications used by various countries including Indonesia is the functional classification made by the Centers for Disease Control (CDC) which categorizes the agents into Agents A, B, and C. Some of these classifications include:

A. Category

   Category A are high-priority agents that pose a risk to national security, can be easily transmitted and disseminated, result in high mortality, have the potential for major public health impacts, can cause public panic, or require special measures for public health preparedness.

   Some examples of biological agents categorized under Category A are:

   a. SARS is a contagious disease. Transmission of SARS occurs when a person accidentally inhales saliva splashes released by a SARS sufferer when sneezing or coughing.

b. Tularemia or commonly known as rabbit fever is a disease caused by the bacterium Francisella tularensis. Tularemia is a dangerous disease because it can infect the skin, eyes, and lungs of humans which can cause death.
c. Anthrax is a disease caused by the spore-forming bacterium Bacillus anthracis. Anthrax's ability to produce microscopic spores makes it easy to penetrate porous skin and can cause sudden symptoms within 24 hours of exposure.
d. Bottulinum toxin is the most dangerous neurotoxin in the world. This toxin is produced by the bacterium Clostridium botulinum, this type of bacteria is very easy to find in nature.
e. Bobunic plague (PES) is a disease caused by the bacterium Yersinia pestis. PES was a deadly disease that almost wiped out the entire population of Europe in the 18th century.

B. Category B

Category B agents are fairly easy to disseminate and have a low mortality rate. Some examples of biological agents categorized under Category B are as follows:

a. Brucellosis is an infectious disease caused by Brucella bacteria. The disease is usually characterized by symptoms of fever, joint pain and fatigue. These symptoms can last for weeks to months. Brucella bacteria can enter through the eyes, skin, mucous membranes, respiratory tract and digestive tract and survive in the cells. Brucella bacteria can move from one organ to another through the bloodstream and lymphatic system. As a result, the infection may be limited to a particular organ or spread to other parts of the body.
b. Glanders is a common zoonotic disease found in horses caused by the bacterium Burkholderia mallei. This bacterium was used by the Japanese and Germans in the First World War to cause their enemies to become limp and respiratory distress. Although it is known that Glanders has a low mortality potential, the rate of spread is very fast because it can be spread from human to human as well as from animal to human.
c. Melioidosis is a disease caused by infection with the bacterium Burkholderia pseudomallei which is easily found in soil and can enter the human body if carried by dust. Melioidosis is a zoonotic disease which means it can be transmitted from one human to another. Although not deadly, Melioidosis that is not treated properly can cause organ damage, especially the lungs.

d. Psittacosis or parrot fever is a rare infection caused by the bacteria Chlamydia psittaci. As the name implies, the medium of transmission of this disease is from birds. A person can contract psittacosis by directly touching an infected bird. In addition, inhaling small particles of urine, feces, or other body fluids from infected birds can also infect a person. People who have been infected with psittacosis can also transmit it to fellow humans. This happens when a person inhales droplets when a person with psittacosis is coughing or sneezing. However, transmission in this way is more rare.
e. Q fever is caused by the bacterium Coxiella burnetii. Humans can contract this bacteria if they inhale dust or eat contaminated food. This disease is also a zoonotic disease so it can spread very quickly.

C. Category C

Category C agents are novel pathogens engineered for mass dissemination due to their availability, ease of production and dissemination, high lethality, or ability to cause major health impacts. Some examples of biological agents categorized under Category C are as follows:

a. Hanta Virus, a virus that causes pulmonary syndrome, is very deadly because it can cause respiratory distress leading to death. The disease caused is zoonotic because it can be transmitted easily through the droplets of infected humans to other humans.
b. Nipah Virus, a virus that causes brain inflammation (encephalitis) which is very deadly. This virus is a zoonotic virus so the rate of spread can be very high.

The following is Table. 1 which displays biological agents classified into three categories based on their threat level and impact on the human population:

Table 1. Classification of Biological Agents According to CDC

Category	Agents Example	Threat Level	Characteristics
A	SARS, Anthrax, Tularemia, Botulinum, Plague	Very High	Rapid transmission, high mortality, causes panic
B	Brucellosis, Glanders, Melioidosis, Q Fever	Medium	Moderate contagiousness, low mortality
C	Hanta Virus, Nipah Virus	High Potential (Genetic Engineering)	New pathogen, easy to spread, significant health impact

Source: CDC, retrieved from Farida (2009); Hariyanto (2022)

The Threat of Bioterrorism in the Age of Advanced Technology

Advances in genetic engineering make it possible to produce biological weapons cheaply and quickly. Compared to nuclear weapons, biological weapons are easier to hide and do not damage infrastructure (Dwipratama, 2023). The biggest challenge lies in the difficulty of early detection and weak legal instruments in Indonesia. Biological attacks have long been used to attack the enemy through relatively simple means such as contaminating wells or other water sources in the opponent's territory during the war in Europe and the American civil war. In its development, biological attacks are used as a medium to commit acts of terrorism. Bioterrorism attacks are generally defined as a form of action that intentionally releases biological agents (pathogens) or biotoxins (toxic substances produced by living things) in the environment occupied by humans, plants, or animals with the aim of spreading diseases that can cause fear, social disruption, and even death.

In Indonesia's history, it has never been officially reported that a form of bioterrorism has occurred. So far, terrorists have used bombing and shooting patterns that usually target Western embassies, churches, temples, Western tourists, public facilities, and police posts, such as the Bali bombing tragedy. However, as a countermeasure, the Indonesian government must begin to pay attention and study the forms of attacks that can be classified as media for bioterrorism crimes, especially with technological advances in the era of society 5.0. For the covid-19 pandemic, it is not included in bioterrorism attacks because of its global impact, besides that the spread is also not from terrorism groups.

With the high potential for bioterrorism crimes in Indonesia, the government's strategic step that needs to be taken is to make regulations on the bill related to bioterrorism, so that there is a specific or limitative legal basis governing how preventive actions to prevent bioterrorism crimes in Indonesia. In addition, setting up a coordination system in tackling bioterrorism if it occurs in the future must be made so that the security and stability of the State can still be guaranteed in the event of a form of bioterrorism attack (Hariyanto, 2022).

Biological weapons have the characteristics of being easy to produce and spread, and can paralyze or kill individuals with the same results. The results of the use of biological weapons have consistency in the form or effect that is the same even though it is spread in different regions or areas. Biological agents can also be produced quickly and cheaply (Educational Foundation for Nuclear Science, Inc, 1964). Biological agents used as biological weapons have a long incubation period in the body of the sufferer, so they can be transmitted and spread widely before being detected (Charles, 2005).

SPARS Pandemic Scenario 2025-2028

There is a scenario of the actual threat of a global pandemic in the future, which this scenario is not a conspiracy, but a hypothetical scenario designed at the Johns Hopkins Center For Health Security. The Johns Hopkins Center for Health Security is an independent institution under the auspices of the John Hopkins Bloomberg School of Public Health and is located at 621 East Pratt Street Suite 201 Baltimore United States. This institution created a scenario of the actual threat of a global pandemic in 2025 to 2028. Broadly speaking, the scenario has the following timeline:

1. 2025 Scenario: The first case of death from a virus called SPARS in the United States occurred in October. A month later, the SPARS virus spreads to 26 states and countries around the world. The WHO expressed the need for serious international attention to this pandemic. There was no proper treatment or vaccine for SPARS until December and the use of kalocivir became an alternative treatment.
2. 2026 Scenario: In January, the US Government contracted with CynBio to develop and produce a human SPARS vaccine based on an animal vaccine. Kalocivir, which had been used to treat SARS and MERS patients, became an alternative treatment for SPARS patients. In April, CynBio successfully produced a SPARS vaccine called corovax. Distribution of the corovax vaccine was carried out globally even though in August it experienced rejection from various layers of the global community, including anti-vaccine activists. In September, Japan declared that it would not use corovax and would develop and produce its own vaccine. In November, there were many reports of SPARS survivors experiencing pneumonia.
3. 2027 Scenario: The increase in pneumonia cases experienced by SPARS survivors led the government to increase antibiotic production and distribution to various states. In May, there are reports of adverse neurological events from the corovax vaccine, especially in children.
4. The 2028 Scenario: In August, the SPARS pandemic was officially declared over, but experts remain concerned about the potential threat of another outbreak in the future.

The following is Table. 2 which displays the timeline of the SPARS Pandemic scenario:

Table 2. Timeline Skenario SPARS Pandemic

Years	Key Events
2025	First SPARS virus death in the US; global spread begins
2026	Corovax vaccine development; vaccine rejection in some countries
2027	Neurological side effects in children; antibiotic distribution initiated
2028	SPARS pandemic declared over

Source: Johns Hopkins Center for Health Security (2017)

The actual threat scenario of a global pandemic compiled by the Johns Hopkins Center for Health Security generally illustrates the importance of preparation in the face of an outbreak or pandemic starting in 2025. From the response scenario timeline, it can be seen that the SPARS vaccine is ready for production and distribution in just 6 months from the first case of death. In addition, SPARS survivors are still at risk of pneumonia and neurological disorders. An outbreak or pandemic scenario from the first case until it is officially declared over takes only 3 years. Advances in biotechnology and genetic engineering have made it easier for countries and unfortunately terrorist groups (even lone wolf) to have relatively easy access to biological weapons and create biological warfare capabilities (Kumar, 2021). The sophistication of biotechnology and genetic engineering can have a positive impact on a country's technological progress. Such sophistication can also have a negative impact if accessed by terrorists or even lone-wolf operators in making biological weapons. Unlike nuclear weapons, the use of biological weapons does not damage facilities and infrastructure, so it can be reused (Dwipratama, 2023).

Bioterrorism Threat Prevention, Response, Preparation, and Countermeasure Strategy

Based on the scenario compiled by the Johns Hopkins Center for Health Security (2017) above, the steps we should take are to prepare and start preparing strategic plans about everything and conditions so that the Unitary State of the Republic of Indonesia is ready and not overwhelmed when the scenario actually occurs. These steps can be in the form of drafting regulations or bills related to biological weapons or bioterrorism as well as regulations for other interests such as lockdowns etc., as well as preparing from an overall perspective such as increasing equipment and personnel capabilities in the TNI AD Zeni Corps unit as well as in the Police Brimob Corps, especially Densus 88 & the Gegana team, preparing medical equipment and equipping health workers with knowledge about these viruses, preparing subsidy costs for state spending needs when the above pandemic occurs, and others.

The following is Table 3 which will display the national strategy in preparing for countering the threat of bioterrorism:

Table 3. National Strategy to Counter the Threat of Bioterrorism

Aspect	Strategic Steps
Legal	Drafting the Bioterrorism Bill; strengthening the Criminal Code and the Terrorism Law
Military Technical	Strengthening the capacity of Zeni Corps TNI AD & Gegana Brimob, procurement of detection & protective equipment
Health	Training of medical personnel, provision of PPE & rapid vaccination
Ekonomy	Emergency budget allocation; incentive scheme for affected sectors
Intelligence	Dark web risk mapping and the illegal biological weapons trade

The national strategy in dealing with the potential threat of bioterrorism must be holistic and cover various aspects across sectors, ranging from law, military, health, economy, to intelligence. In the legal field, the main urgency is the drafting of a Bioterrorism Bill (RUU) that is specific, firm, and limitative, in order to close the national legal vacuum that has so far only relied on general rules on terrorism or criminality. With special regulations, prosecution of perpetrators, supervision of biological laboratories, and protection of human rights can be carried out proportionally and accountably. The law must also regulate lockdown mechanisms, quarantine, drug distribution, and logistics allocation when a biological emergency occurs.

From the military technical side, the role of the TNI AD Zeni Corps unit, Densus 88 and the Gegana Brimob Polri team must be strengthened both in personnel capacity and infrastructure. Equipment such as bioagent detectors, decontamination systems, hazmat protection, and mobile laboratories are vital needs in rapid response to biological attacks. Simulation exercises and cross-agency command integration must also be routinized to strengthen interoperability in crisis situations. This improvement in operational capabilities is not only for mitigating attacks, but also in evacuation and recovery efforts of affected areas.

Meanwhile, in the health aspect, increasing the capacity of the national health system is key. Training medical personnel in early detection of bioagents, handling victims, and controlling the spread of disease are strategic steps. Referral hospitals must be equipped with high-standard isolation rooms and biosafety level 3 or even 4 systems. In addition, the supply chain for personal protective equipment (PPE), medicines, and vaccines must be ensured with a fast distribution system throughout the region. In the economic sector, countries need to have a national emergency budget scheme to deal with biological crises. The COVID-19 pandemic is proof that biological disruptions can have a direct impact on the fiscal sector, trade, and public welfare. Therefore, it is necessary to prepare incentive mechanisms, subsidies, and social security protection for vulnerable groups in situations of outbreaks or biological attacks.

In the intelligence aspect, the government must strengthen the early detection function by utilizing digital monitoring technology, tracking the illicit trade of bioagents, and penetrating the dark web network where the distribution of hazardous substances often occurs. Coordination between the National Intelligence Agency (Badan Intelijen Negara - BIN), BAIS TNI, Intelkam & Cyber Polri, the National Cyber and Crypto Agency (Badan Siber & Sandi Negara - BSSN), and national research institutions such as BRIN is essential to map potential threats from within and outside the country. Intelligence strategies should also be directed at detecting possible insider threats or collaboration between domestic actors and international terrorist networks. With such a cross-sector strategic approach, Indonesia will be better prepared to deal with the complex and unconventional threat of bioterrorism. Integrated prevention, mitigation and response are the foundation for a strong and adaptive national biodefense system in the future.

CONCLUSIONS AND RECOMMENDATIONS

Biological weapons and bioterrorism are real strategic threats to Indonesia. Without a strong legal system, health preparedness, and inter-agency synergy, Indonesia will be highly vulnerable to such attacks. The need to respond to scenarios such as SPARS should be an important lesson in the national unconventional defense strategy. This research highlights the threat of biological weapons and bioterrorism as one of the increasingly relevant strategic national security challenges in the era of globalization and the Fourth Industrial Revolution. Through a literature review and the fictional scenario of the SPARS Pandemic developed by the Johns Hopkins Center for Health Security, it is identified that biological weapons are not just a theoretical potential threat, but also a real possibility in the future, especially when combined with advances in biotechnology and the sophistication of genetic engineering.

Biological weapons have characteristics that distinguish them from conventional or even nuclear weapons, namely their ability to spread silently, without explosions, and often unnoticed until it is too late. Biological agents such as viruses, bacteria, and toxins can be genetically modified to enhance virulence, incubation period, or resistance to drugs, making them a highly effective tool for causing significant social, economic, and psychological damage. This poses new challenges for developing countries like Indonesia, which are not fully ready in terms of infrastructure, law, and human resource capacity to systematically face biological attacks.

Several vulnerabilities of Indonesia to bioterrorism are supported by several factors: weak legal regulations that specifically govern bioterrorism; minimal preparedness of military and civilian personnel for emergency response; and low public awareness of such silent threats. Currently, there is no law that explicitly and restrictively discusses the mitigation of biological weapons, making law enforcement and preventive measures very limited. In fact, in a global context, the misuse of biological technology does not only come from enemy states, but also from non-state terrorist groups, and even individual perpetrators (lone wolves).

Through the CDC's classification of bioagents divided into three categories (A, B, and C), it is evident that the potential damage caused by these agents varies significantly, ranging from highly lethal ones like anthrax and botulinum toxin to pathogens that are easily spread but have a lower risk. Nevertheless, all types of agents still have the potential to be misused as bioterrorism tools if not closely monitored.

To this end, the strategies recommended in this research include: the development of a comprehensive and futuristic draft law (RUU) on Bioterrorism; increasing the capacity of specialized personnel such as the TNI AD (Republic of indonesia National Army) Engineers (Zeni Corps) and Brimob Police's Gegana unit & Densus 88 (Special Anti-Terror Detachment 88); training healthcare personnel in early detection and management of biological infections; as well as flexible national emergency budget allocation in biological emergency situations. Strengthening cross-sectoral cooperation between the ministries of health, defense, research, and intelligence is a key element in creating a resilient national system against biological threats. Thus, in order to protect the sovereignty and safety of citizens, Indonesia needs to immediately develop a comprehensive and anticipatory approach to the threat of bioterrorism. This approach is not only based on military or security strength, but also on strengthening public health systems, regulating biological technology, as well as public literacy regarding biological security. Resilience to bioterrorism is an integral part of modern national defense.

ADVANCED RESEARCH

Further research on "the *Threat of Biological Weapons and Bioterrorism to Indonesia's National Security*" should focus on strategic, legal, and technical approaches to strengthen national resilience against unconventional threats that are asymmetric and cross-sectoral in nature. In-depth studies should be directed toward mapping the potential biological threats posed by both state and non-state actors, as well as Indonesia's vulnerabilities in terms of health systems, security infrastructure, and social stability. The research should emphasize the integration of early warning systems, the enhancement of biosecurity laboratory capacity, and the development of a rapid national response system using advanced technologies such as artificial intelligence (AI), data analytics, and geospatial-based predictive modeling. These technologies are crucial for the timely detection and mitigation of bioterrorist attacks or the spread of dangerous pathogens.

From a legal perspective, a comprehensive evaluation of Indonesia's regulatory preparedness such as Law No. 5 of 2018 on Terrorism Crimes—and alignment with international obligations like the Biological Weapons Convention (BWC) must be prioritized. Harmonization between civil and military legal instruments is essential to ensure a coordinated response to bioterrorism threats. In addition, integrating CBRN (Chemical, Biological, Radiological, Nuclear) defense systems and utilizing C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) command systems will strengthen the nation's response capabilities in biological crises. Strengthening synergy among the Indonesian National Armed Forces (TNI), the National Police (Polri), the National Disaster Management Agency (BNPB), the Ministry of Health, research institutions, and academia is critical to achieving comprehensive biological resilience. Strategic evaluation should also cover public awareness, the readiness of medical infrastructure, vaccine and equipment logistics systems, and national crisis communication protocols. The

expected outcome of this research is to serve as the foundation for developing a national biosecurity policy that is adaptive, integrated, and responsive to evolving threats, while also contributing to the holistic modernization of Indonesia's national defense system.

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