Implementation of Medical Hazardous and Toxic Waste Management Regulations in Hospitals

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Abstract

The rapid growth of hospital facilities has given rise to a new problem in the form of a surge in the volume of untreated hazardous and toxic (B3) medical waste. This study aims to examine the implementation of legal policies on B3 waste management in hospitals based on empirical data and national regulatory frameworks. The research employs a qualitative analysis related to legal norms. The main findings indicate that the management of B3 medical waste in hospitals faces obstacles at various stages, including collection, segregation, storage, transportation, and disposal. Prominent issues include the low capacity of self-managed waste treatment facilities, overlapping regulations, dependence on third parties, and weak monitoring and control of illegal dumping. Moreover, some hospitals still rely on conventional waste management methods, while the implementation of incinerators and new technologies is hindered by licensing and investment costs. The application of the waste management hierarchy principle and region-based management efforts are considered ineffective due to a lack of outreach, incentives, and training for staff. The implications of these issues extend to a decline in service quality, increased risk of disease transmission, environmental problems, and obstacles to achieving hospital accreditation. The results of this study are expected to serve as a reference for establishing new policies and developing more adaptive, participatory, and responsive models for B3 medical waste management, while promoting healthy and environmentally friendly healthcare services.

Keywords:
Environment; Hazardous waste; Hospitals; Law policy; Medical waste.

JEL Code: Q53

Received Month Date Years; Received in revised form Month Date Years; Accepted Month Date Years; Available online Month Date Years (Written by editor)

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INTRODUCTION

In recent years, Indonesia's healthcare sector has received increasing attention due to rapid economic growth, urbanization, and rising public awareness of the importance of health. These factors have driven major transformations within the healthcare system, leading to a significant expansion of healthcare facilities across the country. Both government and private institutions have established clinics, hospitals, community health centers (puskesmas), and public health service centers to meet the growing public demand for medical services. This expansion is expected to enhance the overall quality of healthcare and improve public access to essential services. The growing number of healthcare facilities shows that both government and private sector are paying more attention to public health needs. However, this growth also brings new challenges that must be carefully managed (Fushen, 2025; Romauly & Darma, 2023).

As healthcare institutions expand, they not only increase access to services but also generate more waste and require better resource management. The larger the system becomes, the more complex its operations and infrastructure needs are, making it necessary to adapt policies accordingly. This situation needs a more careful management to ensure that the growth of the healthcare sector is accompanied by the environmental balance and service quality. System integration must be strengthened to anticipate risks that come with the rising number of healthcare users. Consequently, the rapid development of hospitals is closely linked to the emergence of new challenges that require comprehensive solutions at various management levels (Zhang et al., 2024). At the same time, the growing demand for medical services shows that public health issues are still not fully resolved. The rise of various diseases and emerging health challenges has driven hospitals to continuously expand their infrastructure and services, which in turn has led to a significant increase in the amount of waste generated by these facilities (Komilis et al., 2012).

One crucial aspect that is often overlooked is the potential danger posed by hazardous and toxic (B3) waste generated by healthcare facilities, especially hospitals (Arumdani, 2021). Hospitals contribute significantly to the production of various types of B3 waste, including solid waste, infectious waste, pharmaceutical waste (expired medicines), and residues from medical procedures. Nearly all hospital waste falls under the category of hazardous and toxic waste (Padmanabhan & Barik, 2019). The management of B3 waste presents a serious challenge that requires special attention, as improper handling can directly impact human health, cause environmental pollution, and disrupt ecosystem balance (Hassan & Saleh, 2022). The risks include the spread of infectious diseases, air pollution from non-standard incineration, and soil and water contamination due to improper waste disposal (Borowy, 2020).

The Indonesian government recognizes the urgency of managing B3 waste and has issued several regulations, including Law No. 32 of 2009 on Environmental Protection and Management and the Minister of Environment and Forestry Regulation No. 56 of 2015. These regulations mandate hospitals to manage B3 waste comprehensively, covering every stage from reduction, segregation, storage, and transportation to processing and final disposal (Yustina, 2021). Despite these regulations, numerous challenges persist within healthcare facilities (Ali et al., 2017). Data from the Environmental Impact Management Agency (Bapedal) reveal frequent cases of open dumping, unlicensed waste treatment, and non-compliant waste incineration. There are also cases of improper waste storage and the suspension of incinerator operations due to licensing issues. The accumulation of these issues has resulted in the buildup of B3 waste in hospitals, exacerbated by the limited capacity of internal waste management systems in many institutions. Since hospitals primarily focus on providing medical services, their autonomy in handling B3 waste remains limited (Samant et al., 2018). Moreover, their dependence on third-party waste management services often reduces the overall efficiency and effectiveness of waste management practices.

The problem is further aggravated by the lack of technical expertise in integrated medical waste management at the hospital level (Awodele et al., 2016; El Morhit et al., 2021). For instance, the use of incinerators as a waste disposal technology is often hindered by the hospital's proximity to residential areas, potential air pollution, and the absence of standardized operating procedures. These conditions highlight the urgent need for comprehensive policy reform and solutions (Maulia et al., 2025). The urgency of finding solutions for hospital B3 waste management is increasingly important, as it relates to service quality assessments, hospital accreditation, and the protection of public health and the environment. Therefore, mitigation strategies must involve all relevant stakeholders through policy formulation, measurable action plans, and disciplined implementation of standard operating procedures for each stage of waste management. Improving hospital B3 waste management begin with identifying challenges, assessing the readiness of regulatory frameworks, and involving all stakeholders. Collaboration among hospitals, the government, and the community is essential to ensure safe, sustainable, and environmentally responsible healthcare services.

The objective of this study is to analyze and evaluate the legal framework for managing B3 medical waste in Indonesian hospitals and to identify the challenges and solutions in its implementation. The research focuses on understanding how existing regulations, including Law No. 32 of 2009 and Government Regulation No. 101 of 2014, are applied in daily practice at healthcare facilities to assess their effectiveness in ensuring safe and responsible waste management.

Furthermore, this study explores the relationship between B3 waste management policies and their impacts on public health and the environment. By analyzing hospital waste management practices, it aims to identify gaps in regulatory enforcement that may result in improper handling and environmental or health risks. Based on these findings, the research seeks to provide policy recommendations to enhance the B3 waste management system through a more integrated and adaptive approach. This study is expected to serve as a reference for policymakers, healthcare practitioners, and academics in raising awareness and understanding of the importance of sustainable B3 waste management. It also seeks to contribute to the development of more effective waste management policies and practices in the future.

RESEARCH METHOD

This study employs a qualitative juridical-normative approach, focusing on literature review and analysis of laws and regulations related to the management of B3 waste in hospitals. This approach aims to examine the principles, norms, and legal provisions governing B3 waste management through an in-depth review of primary legal documents such as laws, government regulations, ministerial decrees, and other technical regulations relevant to the research topic. In addition, the study also refers to secondary legal literature, including scientific studies, academic papers, and official documents issued by competent environmental and health authorities.

The analysis is conducted qualitatively by identifying and interpreting the normative rules applicable to B3 waste management in hospitals. Each legal document is systematically examined to identify points of convergence, synchronization, and harmonization among existing regulations, as well as their juridical application in practice. The results of this analysis are presented in a descriptive form, aimed at formulating legal recommendations and guidelines for B3 waste management, thereby providing a comprehensive normative perspective to address legal issues surrounding hospital B3 waste management.

FINDINGS AND DISCUSSION

Legal Basis of Hazardous Medical Waste Management in Indonesian Hospitals

The management of B3 medical waste in Indonesian hospitals is based on a clear and structured legal framework, with Law No. 32 of 2009 on Environmental Protection and Management as its main foundation. This law defines B3 waste as materials, energy, or substances that may cause harm, pollution, and pose risks to the environment and human health depending on their quantity, type, or concentration. It requires comprehensive management of B3 waste, encompassing storage, processing, utilization, reduction, collection, containment, and transportation (Nurhayati & Racha, 2024).

In practice, multiple legal instruments have been layered to ensure B3 waste management is implemented at every stage. These regulations translate the law from normative principles into concrete actions, providing procedural clarity and defining the responsibilities of all actors, including healthcare facilities. The government's role in regulating every step, from waste reduction to transportation, is crucial to prevent legal gaps that could harm the environment. Daily operational challenges, however, require stronger coordination and consistent enforcement, along with regular supervision and clear reporting mechanisms to avoid creating new risks for the community. Therefore, the obligations of all parties must be clearly defined within an adaptive and effective legal framework (Rahmawanto, 2025). Thus, the clarity of each party's obligations must continue to be emphasized within an adaptive and effective legal framework.

Article 59 paragraph (1) of Law No. 32 of 2009 mandates that every party generating B3 waste must manage it. If they are unable to carry out the management independently, this responsibility may be transferred to another party holding the proper permit under applicable laws. In hospitals, this legal provision serves as the operational basis for managing B3 waste through all stages, from treatment to final disposal (Absori & Latif, 2020). Government Regulation No. 101 of 2014 further elaborates and clarifies B3 waste management procedures, requiring all business entities, including hospitals, to handle waste according to the law, encompassing collection, storage, transportation, treatment, disposal, and destruction (Hariyanto et al., 2021).

The requirements for managing B3 waste and obtaining permits are detailed in Article 59 of the Environmental Protection and Management Act (UU PPLH). Paragraphs (1) and (4) specify that B3 waste management is an administrative regulations for business entities, which must be carried out after obtaining authorization from the Minister of Environment and Forestry or equivalent provincial or regency/city officials within their jurisdiction (Absori & Latif, 2020). This obligation is grounded in the theory of pure normative law, which emphasizes that legal norms must be followed hierarchically. Consequently, all technical, administrative, and licensing policies related to B3 waste management in hospitals must adhere to and not contradict the fundamental legal norms, including the Constitution and UU PPLH as the *lex specialis*. This ensures that hospital-level policies, standard operating procedures (SOPs), and collaborations with third parties operate within Indonesia's established hierarchical legal framework (Himayati et al., 2018).

In its implementation, the central government, through the Ministry of Environment and Forestry, is responsible for policy formulation, technical regulation, licensing, supervision, facilitation, and evaluation, as emphasized in various technical regulations such as the Minister of Environment and Forestry Regulation No. P.56/Menlhk-Setjen/2015 concerning Procedures and

Technical Requirements for the Management of Hazardous and Toxic (B3) Waste from Healthcare Facilities. Regional governments are mandated to support and facilitate the implementation of an integrated B3 waste management system through local regulations and other supporting instruments based on the regional needs (Hariyanto et al., 2021). Hospitals, as producers of B3 waste, are obligated to consistently follow established protocols and standard guidelines, including ensuring that partnerships with third parties are properly licensed and strictly supervised. Both healthcare facility partners (Fasyankes) and waste transporters or management agents must comply with regulations, meaning that all processes, from waste handling and manifest submission to reporting and documentation, must conducted transparently and can be legally accountable (Syakur, 2024).

The environment, including its social, political, and economic dimensions, is a key factor in all policies related to hospital B3 waste management. Economic pressures often drive hospitals to adopt efficiency by outsourcing waste management to third parties. However, hospitals are legally responsible for ensuring that all processes comply with existing regulations (Febrina, 2023). Technical and financial limitations are major factors behind this outsourcing preference. Yet significant challenges persist, including the limited number of licensed incinerator facilities, inadequate waste processing infrastructure, and the accumulation of fly ash and bottom ash that require disposal in landfills, as stated in the Minister of Environment Regulation No. 14 of 2013 on Hazardous Waste Symbols and Labels and supported by field observations.

The implementation of waste management, including reduction, segregation, packaging, storage, transportation, processing, landfilling, and disposal, has not yet fully complied with existing regulations. A significant gap remains due to the limited number of licensed national waste treatment facilities and the occurrence of illegal medical waste dumping, resulting from weak enforcement and oversight (Pertiwi et al., 2017). Waste reduction activities are regulated under Government Regulation No. 101 of 2014, Article 10 (1) and (2), which allows minimization through environmentally friendly technologies, process modification, and material substitution. However, in practice, the implementation of the 3R program (reduce, reuse, recycle) and eco-friendly chemical cleaning methods remains very limited. Regulations on waste segregation, outlined in the Minister of Environment and Forestry Regulation No. 56 of 2015, mandate that hospitals separate waste according to its characteristics. However, issues such as SOP failures, incorrect waste classification, and improper use of color-coded or symbol-labeled containers remain ongoing problems. Waste collection procedures follow Government Regulation No. 101 of 2014, Article 1, point 21, concerning the management and collection of waste before transfer to licensed waste users, processors, or

disposers. The regulation also requires manifest documentation and worker protection to prevent violations of labor rights and occupational safety (Absori & Latif, 2020).

Obstacles in the B3 waste management system have also led to waste accumulation in temporary storage facilities (TPS), mainly due to slow or disrupted transportation processes. Consequently, illegal waste disposal practices have become increasingly frequent, causing serious environmental impacts such as soil and water pollution, as well as posing significant health risks to the broader community (Buana, 2021).

To address the various challenges in managing B3 medical waste in hospitals, systematic and integrated efforts are required through the synergy of regulatory, operational policy, supervisory, and guidance aspects. The primary step that must be taken is to strengthen the implementation of Law No. 32 of 2009 on Environmental Protection and Management, Government Regulation No. 101 of 2014 on Hazardous and Toxic Waste Management, as well as supporting regulations such as the Minister of Environment and Forestry Regulation No. P.56/Menlhk-Setjen/2015 and Minister of Environment Regulation No. 14 of 2013 concerning Symbols and Labels for B3 Waste (Yustina, 2021).

The initial step, in the form of regulatory harmonization and updates, must go hand in hand with the development of more adaptive and implementable standard operating procedures (SOPs). The government, both at the central and regional levels, must conduct regular outreach and supervision of the implementation of these regulations at the hospital level. Facilitating easier licensing processes—so that hospitals, particularly those in regional areas, no longer face administrative barriers to obtaining permits as stipulated in Article 59 paragraphs (1) and (4) of Law No. 32 of 2009 and Government Regulation No. 101 of 2014 is an essential step to promote legal compliance (Absori & Latif, 2020).

Governance improvements must be carried out at every stage of waste management (Purwanti, 2018). At the reduction stage, the implementation of waste reduction targets through the use of environmentally friendly technologies and the substitution of hazardous materials needs to be clarified as a form of implementing Article 10 paragraphs (1) and (2) of Government Regulation No. 101/2014. Hospitals are encouraged to replace mercury-based medical equipment with non-mercury alternatives and to strengthen 3R (reduce, reuse, recycle) programs with support and incentives from the government.

The segregation and packaging stage of hazardous and toxic (B3) waste, in accordance with the Minister of Environment and Forestry Regulation No. 56/2015 and Regulation No. 14/2013, must be carried out by improving internal SOPs and providing packaging that meets the required standards for

color, symbols, and waste codes. Enforcing discipline among healthcare workers in waste segregation, along with regular training on occupational safety and the use of personal protective equipment (PPE), is highly necessary (Hariyanto et al., 2021).

At the stages of waste collection, storage, and transportation, management must comply with the regulations on collection, temporary storage, and transport as stipulated in Government Regulation No. 101/2014 Articles 1 points 20 and 21, as well as the Minister of Environment and Forestry Regulation No. 14/2013. Hospitals are required to provide a Temporary Storage Facility (TPS) for B3 waste that meets technical standards, utilizing an electronic waste manifest documentation system to ensure waste traceability (Yustina, 2021).

Collaboration with third parties, including transporters and final B3 waste processors, must be based on valid contracts and subject to strict supervision. Regular evaluations of partner performance and the use of an online reporting system by the Ministry of Environment and Forestry will strengthen accountability and prevent misconduct or illegal waste disposal practices. Oversight of waste management companies is also regulated in the monitoring, administrative, and criminal sanction provisions of Law No. 32 of 2009.

Improving infrastructure and technology, such as licensed incinerators, autoclaves, and cold storage, should be pursued through inter-agency partnerships and innovative funding schemes, including CSR funds or environmental financial institutions. The development of regional hazardous and toxic (B3) waste treatment facilities also serves as a solution, enabling hospitals in various regions to form partnerships and reduce dependence on a single waste processor with limited capacity (Maharani et al., 2017).

Consistent law enforcement is the key to effective environmental protection. Administrative and criminal sanctions, as stipulated in Articles 69 to 113 of Law No. 32 of 2009, must be strictly applied to violators—including institutions or third parties proven to have illegally disposed of waste—in order to create a deterrent effect and foster a culture of legal compliance (Yustina, 2021).

Education and empowerment of all stakeholders from hospital management, healthcare workers, and cleaning staff to surrounding communities regarding the dangers of B3 waste and the legal obligations for its management must be carried out continuously. Training programs, dissemination of legal knowledge, and the strengthening of environmental safety culture will build a foundation of legal compliance from the operational level up to strategic policy-making.

Overall, the management system for hospital B3 medical waste, through a consistent juridical-normative approach in implementing all regulatory

instruments, will help prevent environmental pollution and ensure legal protection for human life and environmental sustainability. The synergy between regulation, institutional strengthening, supervision, and legal awareness culture forms the main foundation for achieving the goal of sustainable, health-based development in Indonesia.

Evaluation of Hazardous Waste Management Policies and Strategies

A review of the legal policies on the management of B3 medical waste in hospitals shows that waste management is not merely a technical activity but a multidisciplinary practice embedded in various aspects of organizational life, regardless of the institution's scale. In practice, the implementation of B3 waste management policies in hospitals—especially those involving third parties—still faces numerous challenges. Common issues include negligence and inconsistency on the part of third-party contractors, resulting in waste collection and processing not being carried out in accordance with contractual agreements. This situation contributes to the accumulation of waste within hospitals (Sutanto & Karianga, 2023).

Therefore, it is understandable that coordination challenges between hospital personnel and external partners have become increasingly evident as service demands continue to rise. This situation highlights the importance of designing control mechanisms that minimize the potential for irregularities in the implementation of B3 waste management. Systematic supervision and the establishment of strict standard operating procedures are essential to ensure certainty and accountability throughout the entire management chain.

In line with this, the continuously evolving organizational dynamics of hospitals require policies that are responsive and adaptable to changing circumstances and on-site challenges. At the same time, awareness of the environmental consequences that may arise from improper waste accumulation must remain a top priority for all stakeholders. Although existing regulations already define institutional obligations, effective supervision remains the determining factor for the overall success of the system. Risk perception and a culture of compliance also shape the behavior of actors involved in the management process.

Thus, the complex relationship between internal management, third-party involvement, and external pressures calls for policies that are regularly evaluated to remain relevant to current issues. Furthermore, the establishment of mitigation procedures against violations is equally crucial to prevent greater harm. Altogether, these governance mechanisms serve as the foundation linking practical technical issues with broader structural challenges in subsequent stages (Said et al., 2024).

In addition, changes in the healthcare system due to globalization and decentralization, along with the implementation of the National Health

Insurance (JKN) program, which has led to a surge in patient numbers, have further increased the complexity of the problem. Hospitals often struggle to adjust their B3 waste management capacity to match the unpredictable number of patient visits. Transportation issues also arise due to the considerable distance between hospitals and licensed waste handlers or transporters, making the collection process costly and time-consuming. In some cases, third-party waste contractors take advantage of emergency or urgent situations in hospitals to unreasonably increase waste management fees. Moreover, there have been instances of hospital staff engaging in illegal practices, such as selling medical waste, as a result of waste accumulation in temporary storage areas (Lelyana, 2024).

This phenomenon underscores the need to reassess the effectiveness of B3 waste management regulations to ensure that waste management practices remain efficient and sustainable, even when involving third parties. Ideally, hospitals are strongly encouraged to manage B3 waste independently using available incinerators or other waste treatment equipment. Management strategies should be regularly evaluated to prevent waste accumulation, misuse, and additional environmental burdens that could lead to serious pollution risks. Every environmental risk arising from waste requires firm and proactive protective measures (Buana, 2021).

The waste management hierarchy provides a crucial framework that prioritizes actions in handling medical waste—from prevention, reduction, reuse, and recycling to further treatment and final disposal (Nasrul et al., 2024). Hospitals must apply the concept of a waste management hierarchy through region-based policies, ensuring that each stage, from segregation to final disposal, occurs within the local administrative area (city, district, or province). This regional approach aligns with Minister of Environment and Forestry Regulation No. P.56/2015, which defines seven stages of medical waste management. By optimizing internal waste handling, hospitals can minimize the volume of waste sent outside the facility. Additionally, regional management provides clear guidance on appropriate treatment methods, including incineration, direct landfill disposal for sharps and bottles, and recycling for items like syringes and plastic IV bottles (Apriyanthi et al., 2024). Moreover, hospitals are also responsible for preventing and minimizing environmental degradation caused by medical waste to ensure a healthy and safe environment surrounding healthcare institutions (Larasati et al., 2022).

Government regulations emphasize that hospitals, as producers of B3 waste, bear an irreplaceable responsibility to protect environmental sustainability (Yoga, 2023). From an environmental ethics perspective, this responsibility reflects respect for the sacred right to a healthy environment as an expression of obedience to God, aligning with the theocentric view. Humans and the environment are seen as God’s creations; therefore, protecting and

preserving the environment is a moral obligation, not merely an economic effort. Public attitudes toward B3 waste should be based on a comprehensive management paradigm, meaning that every economic activity must take into account environmental functions and carrying capacity. In this way, B3 waste can be properly managed following appropriate procedural standards. The main step in waste management according to the hierarchy principle is to prevent waste generation, followed by strategies of reduction, reuse, and recycling through chemical, thermal, physical, or biological methods. If waste still remains, it should be treated using thermal methods such as incineration or non-thermal processes before final disposal (Normawati et al., 2021).

As awareness of sustainable environmental management grows, waste treatment technology has become a central focus in protecting public health and ecosystem (Oleniacz & Grzesik, 2025). Hazardous and toxic waste remains a major challenge in many countries, including Indonesia, making effective technological innovation critical for safe and efficient waste management. The application of incinerator technology has proven to be effective and efficient in handling B3 waste, as demonstrated in Japan through its *waste-to-energy* policy. This method not only reduces waste by up to 95% and saves landfill space, but also cuts costs and increases the added value of raw materials (Zeng et al., 2024). By adopting incinerator technology, countries are expected to manage B3 waste more responsibly and innovatively (Setiadi & Rosnawati, 2024). The success of this method not only offers a short-term solution for waste management but also creates opportunities for sustainable economic development. Such efforts are essential to raise public awareness about proper waste management and to encourage collective action in protecting the environment (Maddi, 2024). Therefore, the best B3 waste management policy framework is based on the principles of hierarchy and regionalization. The readiness of hospitals at every stage of waste management is crucial to prevent the risk of new infectious disease transmission among patients; poor waste management increases that risk. Active participation of all staff members and adherence to operational procedures serve as indicators of hospital quality.

The accreditation program monitored by the Ministry of Health and implemented by the independent body KARS is also an important benchmark. Compliance with accreditation requirements, as outlined in the 2018 National Hospital Accreditation Standards (SNARS), is strongly influenced by effective waste management practices. Hospitals with high accreditation scores are those that have upheld strong waste management standards, while those failing to meet them risk losing accreditation status. Therefore, proper B3 waste management not only prevents legal sanctions and protects the environment but also enhances a hospital's reputation, service quality, and overall patient safety.

CONCLUSIONS

The management of medical B3 waste in hospitals continues to face fundamental challenges, including overlapping regulations, limited in-house waste management capacity within healthcare facilities, and inadequate supervision and technical competence in the field. Dependence on third-party waste handlers, the limited number of licensed incineration facilities, weak pollution risk control, and the minimal application of the waste hierarchy principle are among the main obstacles. These issues directly lead to waste accumulation in storage areas, misuse of waste, environmental pollution, and disruptions in hospital service quality and healthcare facility accreditation.

The problem of B3 waste management in hospitals has far-reaching consequences for environmental health and the quality of medical services. Without prompt intervention through strict regulatory enforcement and governance innovation, the risks of pollution and disease transmission will continue to rise, ultimately undermining hospital credibility and accreditation status. This situation highlights the importance of regulatory compliance and cross-sector collaboration as key priorities to build a sustainable system that ensures public safety and environmental protection.

Efforts are needed to consolidate regulations, strengthen law enforcement, and enhance the capacity and infrastructure for B3 waste management in every hospital, through both technological investment and the development of appropriate SOP. The government is expected to provide support in the form of streamlined licensing processes, human resource training, incentives for adopting environmentally friendly technologies, and regular monitoring of healthcare facilities. It is also essential to involve the community in waste control efforts, promote regional collaboration among waste treatment facilities, and strengthen hospital integrity in implementing B3 waste management protocols—ultimately achieving safe, high-quality, and environmentally sustainable healthcare services.

AUTHOR CONTRIBUTION

Didit Darmawan, Rommy Hardyansah: Conceptualisation and Research Design, Data Collection, Methodology, Supervision, **Dharma Setiawan Negara, Rafadi Khan Khayru:** Writing Entire Paper, Conceptualisation, Data Collection and Analysis, and **Rio Saputra:** Data Collection, Editing and Layouting. All Authors have read the final version of the paper.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to thank the anonymous referees for their helpful comments and suggestions.

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