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Literature Review of Slingshot Games and Its Potential Application in Learning Physics

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Abstract

Traditional games are part of local wisdom that preserves cultural values and educational potential. One such game is the slingshot, which is not only known as a hunting tool but also incorporates many concepts of physics such as elasticity, potential energy, kinetic energy, and parabolic motion. This study aims to review the literature on slingshots and their relevance in physics education. Data were collected from Scopus-indexed international publications using the keywords "slingshot OR catapult," yielding 3,013 articles. After applying inclusion criteria and screening based on title, abstract, and keywords, 1,000 articles were selected for analysis using VOSviewer. The results of the study show five main clusters, namely the use of slingshots in aircraft launch, biomechanics, principles in animals, animal experiments, and fundamental aspects of physics. These findings confirm that catapults can be used as a contextual medium in learning to improve understanding of physics concepts and at the same time preserve local culture. By linking indigenous knowledge with scientific principles, this study contributes to enriching physics learning while encouraging the preservation of cultural heritage within modern education.

Keywords: *Slingshot Games, Hooke's Law, Elasticity, Physics Learning, VOSviewer*

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INTRODUCTION

Traditional games are part of the local culture commonly found in Indonesia, especially in villages. These activities are not only entertaining, but also influence psychological development, character building, and scientific attitudes. Most of them use simple natural materials, thereby training creativity and recycling skills (Armaka et al., 2022; Melinia et al., 2024). There are many different types of traditional games that have been passed down from generation to generation, such as spinning tops, stilts, jump rope, mameong-meongan, and slingshots (plenthingan) (Cahyani et al., 2024; Rohmah et al., 2024). This tradition has educational, social, and cultural value (Astuti & Bhakti, 2021; Aryannanda, 2022). In addition, many of them teach physics concepts such as force, energy, motion, elasticity, and balance. Thus, local cultural elements can be a bridge to understanding physics through real experiences, especially in slingshot games.

The slingshot is a traditional game also known as plintengan or slepetan. According to Udi Anwar, deputy chair of the Indonesian slingshot community, slingshots were used in the past as hunting tools, but over time they have evolved into a sport for training agility (Rolina & Linando, 2021). Historically, slingshots were also used as military weapons, but now they are more commonly used as a popular game for children and teenagers. Slingshots work by storing elastic energy in rubber or a string that is pulled back and then released to launch a projectile (Yao, 2024). Slingshots not only embody local wisdom, but also contain many concepts of physics such as elastic potential energy, kinetic energy, parabolic motion, and Newton's laws (Aryani, 2024). These

characteristics make slingshots relevant for study in the context of physics education. As can be seen in Figure 1.

Figure 1. Slingshot Traditional Game (Irawan et al., 2024)

21st-century education emphasizes critical thinking skills, problem solving, and scientific literacy supported by teachers as facilitators (Waruwu et al., 2024; Noptario et al., 2024; Nurkholifah, 2024). Scientific literacy is one indicator of learning success (Dragoș & Mih, 2015). In this context, traditional games such as slingshots have great potential to be used in physics learning, especially to explain the concepts of elasticity and Hooke's Law. Through slingshots, students can relate real experiences to physics principles, such as spring force, potential energy, and kinetic energy. This hands-on practice helps students understand concepts concretely, increases their interest in learning, and brings them closer to their local culture (Deta et al., 2024). This potential is even stronger when viewed through the results of previous studies that have examined slingshots from various perspectives.

Several previous studies have examined slingshots from various fields. According to Bates et al. (2022), slingshots were examined in the field of biomechanics, particularly in relation to force and motion. In the study by Alexander & Bhamala (2020), slingshots were reviewed from a technical and application perspective. The study by Irawan et al. (2024) highlights the accuracy of shots and the ideal grip in traditional games. As explained by Shohag (2023), slingshots carry a high risk of use, especially in terms of safety. Meanwhile, Kumar et al. (2020) reviewed the basic physics concepts in slingshots, although they were not directly related to learning. From these various studies, it appears that the research still predominantly emphasizes technical aspects and risks, so studies that place slingshots as a medium for physics learning are still very limited.

This study aims to review the literature on slingshots and their potential in physics education, particularly in relation to the concepts of elasticity and Hooke's Law. Previous studies have shown that slingshots have been studied extensively from the perspectives of biomechanics, engineering, shooting accuracy, and the risks associated with their use. However, most studies still focus on technical aspects and have not discussed in detail the use of slingshots as a learning medium that connects local wisdom with physics concepts. In addition, studies highlighting the extent to which this traditional game can improve students' understanding of the laws of physics are still limited, so more focused research is needed to explore the potential of slingshots in the context of physics education.

METHOD

The research method employed a literature review study using international publication data indexed by Scopus that is related to Slingshot or Catapult. The search on Scopus was conducted on July 1, 2024, with the keyword "slingshot OR catapult" and yielded 3,013 articles. The bibliographic analysis was visualized using VOSviewer with the type of co-occurrence analysis, covering all keywords, and applying the complete counting calculation method, with a minimum threshold of keywords appearing at least five times. This bibliometric visualization using VOSviewer was aimed at identifying the relationship between discussions on slingshot or catapult (Azzahro, 2022).

A mapping process of the 3,013 articles from Scopus was then carried out based on the following inclusion criteria: article publication level "final," publication year "2003-2023", document type "article," source type "journal," and article language "English". Applying these criteria resulted in a total of 1,000 articles, which were then further screened based on the title, abstract, and keywords to ensure they matched the inclusion criteria for discussions related to slingshot or catapult. These criteria were selected to ensure that the data is up-to-date, valid, peer-reviewed, and consistent with international analysis. The research method flowchart can be seen in Figure 2.

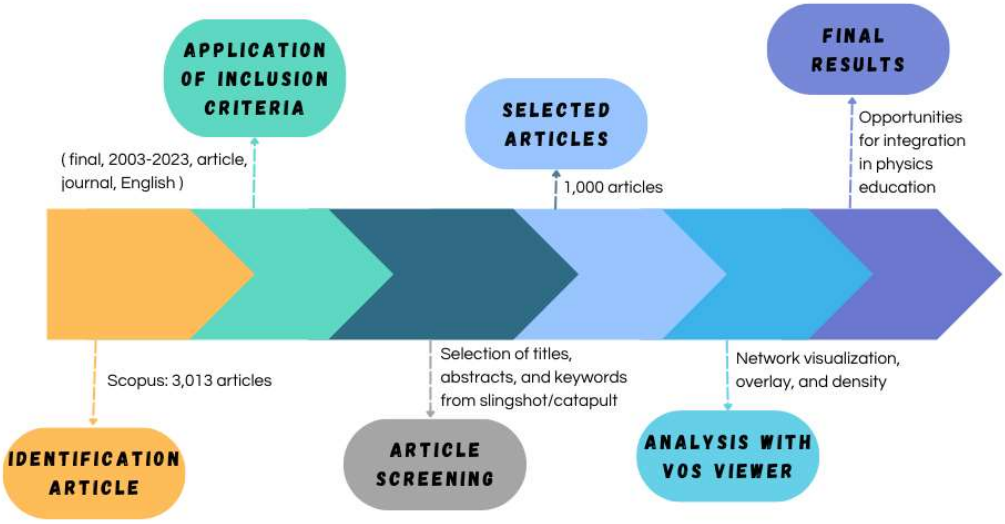

Figure 2. Research Flow

Based on Figure 2, it can be seen that the research method flow was analyzed using VOSviewer. This tool was chosen because it is capable of mapping relationships between keywords, displaying global publication trends, and producing easy-to-understand visualizations of networks, time overlays, and density. The general research flow began with searching for articles in Scopus (3,013 articles), then applying inclusion criteria until 1,000 articles remained, followed by screening titles, abstracts, and keywords to ensure relevance to the topic, and finally bibliometric analysis using VOSviewer. The results of this process are a mapping of dominant themes in the literature and the identification of opportunities for integrating slingshot games into physics education.

RESULTS AND DISCUSSION

Based on the network, overlay, and density visualization generated using VOSviewer from 1,000 articles containing a total of 20,946 keywords, the author determined that a minimum occurance frequency of five was necessary to obtain a set of 1,000 interrelated keywords. The network visualization produced by VOSviewer, which depicts the relationships between keywords, is presented in Figure 3.

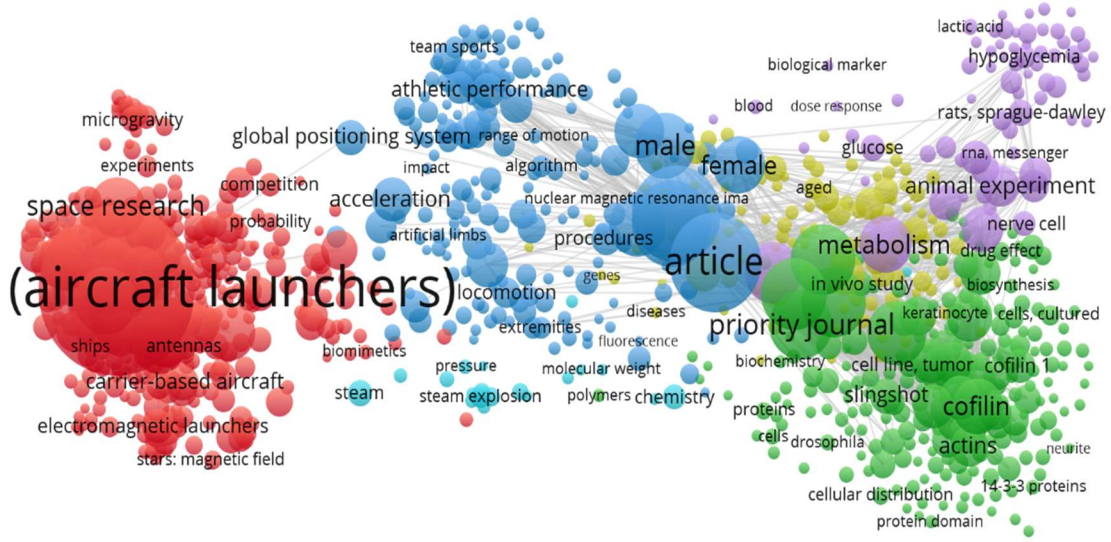

Figure 3. Network Visualization Map "Slingshot"

The network visualization mapping revealed significant findings, displaying five different color groups such as red, blue, green, purple, and yellow clusters. Each cluster is associated with a specific keyword, 'utilization of slingshots in aircraft launching' in the red cluster, 'applications of slingshots in biomechanics' in

the blue cluster, 'principles in animals' in the green cluster, 'animal experiments' in the purple cluster, and 'fundamentals' in the yellow cluster. When linked to physics education, these clusters not only showcase the variety of slingshot uses in science and technology, but also provide an entry point for explaining basic physics concepts.

The red cluster is dominant in the use of catapults in launching aircraft. In this case, it allows for explaining the take-off process to be more efficient, quick and meets the unique needs of flight operations on board aircraft carriers, especially in limited space (Yefremoy, 2023). It is also used in the landing process, requiring more skill than on land because the ship constantly moves, and the runway is short and narrow. In the blue cluster, the dominant application of slingshots in biomechanics is related to the use of slingshot technology in biomechanical analysis. This increases the athlete's ability in various sporting activities.

Meanwhile, the green cluster is the dominant principle in animals. This principle explains the principles of animal welfare, such as the 3R principle (Replacement, Reduction, Refinement). The replacement principle emphasizes the use of alternatives that can replace the use of live animals in research. Although slingshot is not directly related, this principle shows the importance of finding better solutions using resources. Thus, animal principles can improve welfare and reduce animal suffering (Zhong et al., 2023). Although not directly discussing slingshots as an educational medium, these findings emphasize the importance of ethics and alternative approaches in research. This can be reflected in physics education, where simple experiments with slingshots can replace more risky experiments, allowing students to understand the concepts of force, energy, and elasticity without engaging in dangerous experiments.

The dominant purple cluster is an animal experiment. Although the pulling force on the slingshot was not tested on animal behavior, welfare principles can reduce animal suffering. Fundamental dominant yellow cluster. The fundamental slingshot relationship is explained through the physical principles underlying the event of drawing water using a slingshot, among the principles of physics, such as force, motion, potential, kinetic energy, spring force, and friction (Rahesti & Irawan, 2023). These principles work together to make drawing water using a slingshot effective and efficient. In this context, the traditional slingshot game can be integrated as a contextual learning medium that makes it easier for students to understand Hooke's Law, elastic energy, and the concept of projectile motion. By utilizing bibliometric visualization, teachers can see the potential of the slingshot not only as a traditional game, but also as a bridge to connect science with local culture.

Overall, the relationship between the use of slingshots in launching aircraft, the application of slingshots in biomechanics, principles in animals, animal experiments, and fundamentals involves the same physical principles such as spring force, potential energy, and kinetics. In Figure 4, the results of the VOSviewer visualization overlay are shown which present the time span of publication of articles about slingshots.

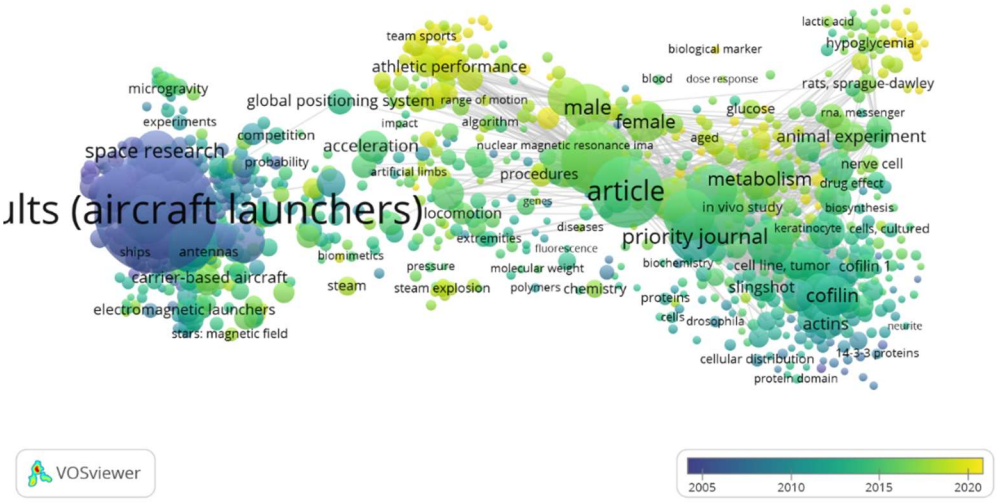

Figure 4. Visualization Overlay Map "Slingshot or Catapult"

The results showed that research on slingshots or catapults was widely published in 2023, marked in yellow. The density visualization map, which presents a mapping of updates from previous researchers, can be seen in the following density visualization map.

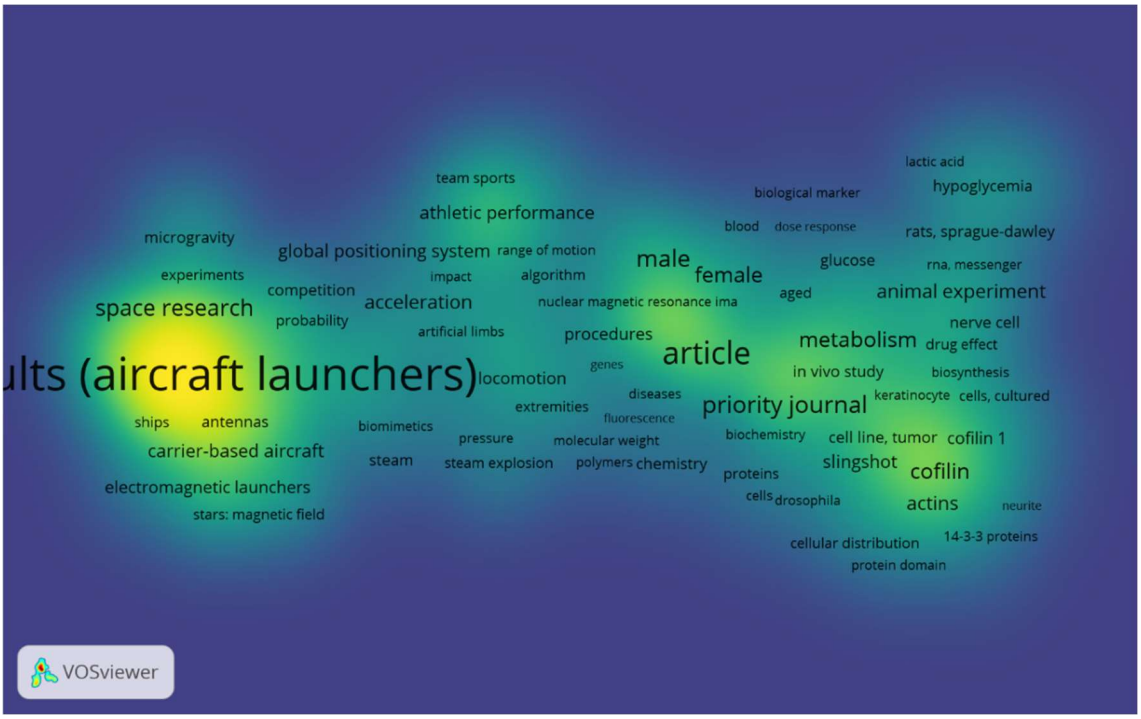

Figure 4. Density Visualization Map "Slingshot Catapult"

Figure 4 shows that the discussion regarding slingshots is green and slightly yellowish, which means that previous researchers have not updated the topic much. On the other hand, the discussion regarding the slingshot is bright yellow, which means there have been many updates from the results of previous research. Of the 1000 relevant articles analyzed based on catapults in that country, a study will later be carried out regarding these catapults in Indonesia.

The visualization map produced by VOSviewer, which shows the relationship between the slingshot discussion, still has the opportunity to create novelty in further research. The author reviewed 1,000 Scopus-indexed research publications examining slingshots. The author's affiliations are from Japan, India, Australia, Estonia, the United States, and the United Kingdom.

Table 1. Analysis Matrix Table "Slingshot"

Author/Year	Title	Method	Results
Lai et al, 2022	Sino-orbital foreign body caused by catapult injury in a boy	Case Study	The use of slingshots is dangerous for children because impacts to the eye sockets result in serious injuries including blindness.
Bates et al, 2022	A High-Speed Launch Mechanism Inspired by a Catapult Spider's Web	Experiment	The body structure of the spider slingshot consists of several radial body elements reinforced with circular body elements providing increased stiffness, in comparison, the web has about eight times the stiffness of a traditional slingshot with a single radial web element. The results show that adapting designs from nature has the potential to yield superior performance to man-made devices.
Alexander & Bhamala, 2020	The slingshot spider launches very quickly using a cone-shaped silk web	Quantitative Observation	Slingshot spiders produce the fastest arachnid whole-body movements through the use of their webs for external hook-mediated spring locomotion.

Author/Year	Title	Method	Results
Uibo, U, 2014	Etymological notes (XV)	Literature Review	The origin of the Estonian words kada 'slingshot', (k)raejalad 'horse, trestle' and õnnar 'tailbone'. The word kada is a shortening of the word kadapulk, which is a folk etymological transformation of the katapult 'slingshot'. The meaning 'slingshot' was acquired by Katapult in German, which mediated the ancient word into Estonian.
Forge, J, 2013	The Development of Projectile Weapons: Ancient Catapults	Research and Development	A view of the evolution of technology, and illustrates it with reference to the catapult. To illustrate, one of the most famous episodes in the ancient world saw military technology skillfully deployed to thwart a powerful enemy.
Irawan, et al., 2024	Slingshot Accuracy in Traditional Games: What is The Ideal Grip in Shhoting? Precision del tirachinas en juegos tradicionales: cual es el agarre ideal al disparar?	Quantitative Methods	This study found the conclusion that the ideal grip is a straight hand position parallel to the pull of the arm until an angle of approximately 90 degrees is formed with the slingshot position slightly tilted, this position can provide enough space for the other hand to pull the slingshot rubber back.

Based on Table 1, information was obtained that slingshot is a traditional game used for hunting in ancient times. Other information states that this slingshot has a dangerous impact on children who lack awareness from their parents or who still don't know how to actually use a slingshot (Shohag, 2023). Several sources said that further research could discuss the analysis of length of pull and shooting accuracy, not just regarding ideal grip biomechanics in traditional games. Apart from that, this slingshot game can be used in the world of education, especially in high school physics learning. Suitable for use by high school-age children because they understand the pros and cons of traditional slingshot games. Physics learning also contains Hooke's law and elasticity from the traditional slingshot game (Kumar et al., 2020). Several sources of software names from the keyword catapult play an important role in improving the performance of athletes and sports teams. Catapult is defined as the technology used in sports to collect athlete performance data connected to GPS or satellites.

Hooke's law explains that force in physics occurs due to the elastic properties of objects or springs (Howard et al., 2023). Hooke's law states, "If the tensile force applied to a spring does not exceed the material's elastic limit, then the increase in the spring's length is directly proportional to the tensile force" (Rahmawati & Malik, 2023; Inayah et al, 2025). The mathematical equation can be written as:

$$F = -k.\ \Delta x \quad (1)$$

where:
F = force (N)
k = spring constant (N/m)
Δx = increase in spring length (m)

Based on Table 1, it appears that the slingshot game in six countries does not explain the use of slingshots. The results of the review show that the relationship between the use of catapults in launching aircraft, the application of catapults in biomechanics, principles on animals, experiments on animals, and fundamentals involving the same physical principles such as spring force, potential energy, and kinetics. However, with an educational approach, these findings can be directed towards strengthening physics learning based on local wisdom. An important implication is that teachers can design project-based learning strategies or simple experiments with slingshots, which not only train students' understanding of physics concepts but also increase their interest in learning through direct experience.

In addition to providing an overview of the application of slingshot games in learning, this traditional game has scientific value that can be linked to local culture. Slingshots not only function as a game tool, but also reflect the principles of physics that can be explained through an ethnoscience approach. Dunggio et al. (2024) developed a slingshot quiz application to explain the concept of energy in life systems and help students understand the material more easily. According to Saharani et al. (2023), slingshot training and community building can improve community skills and revive young people's interest in traditional sports. These findings indicate that the slingshot game has great potential for further development, both in terms of the study of physics concepts and its application in the context of culture and learning in schools.

This study provides a broad overview of the potential of slingshot games in physics education. However, the results obtained are still limited because they are based only on a literature review without direct field testing. References are also limited to Scopus-indexed articles and several national journals, so there is a possibility that other relevant local studies have not been covered. In addition, differences in the forms and terms of traditional games in each region mean that the results of this study cannot be fully generalized. These findings have the potential to serve as a basis for future researchers who test the application of slingshot games in the context of physics learning in schools. Despite its limitations, this study makes an important contribution to the development of more contextual and meaningful physics learning strategies.

The results of this study support the development of high-quality and sustainable physics learning by using traditional games such as slingshots as a medium that is interesting and easy for students to understand. Aryani et al. (2025) showed that local games increase motivation and understanding of physics concepts, while Lestari et al. (2022) emphasized that local wisdom helps scientific understanding through everyday phenomena. The traditional game approach also received positive responses and improved science literacy and contextual learning participation (Laila., 2025). In addition, STEAM slingshot products can be applied in school learning and improve students' 21st century skills (Naufal & Asdar, 2022). Thus, this research has an impact on preserving important cultural values in sustainable education.

CONCLUSION

The literature review confirms that the traditional slingshot game is not only culturally valuable, but also rich in physics concepts such as elasticity, potential energy, kinetic energy, parabolic motion, and Newton's laws. Bibliometric analysis using VOSviewer reveals five main research clusters, namely aircraft launch, biomechanics, principles in animals, animal experiments, and fundamental aspects, which, although emphasizing technical aspects, can still be the basis for integrating slingshots into physics learning. The implication is that teachers can use slingshots as a contextual medium to improve students' scientific literacy, interest in learning, and conceptual understanding while preserving local wisdom. This study is still a bibliometric and literature study, so further research is recommended to conduct experimental studies in the classroom and develop a curriculum based on traditional games.

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AUTHOR CONTRIBUTIONS

Heny Aryani: Conceptualization, Methodology, Investigation, Data Curation, Writing-Original Draft, and Visualization; **Nurita Apridiana Lestari**: Resources, Supervision, Writing-Review & Editing, and Validation; **Budi Jatmiko**: Resources, Supervision, and Validation, **Alfi Nurlailiyah**: Resources, Supervision, and Writing-Review & Editing, **Arie Realita**: Supervision dan Validation, **Antomi Saregar**: Supervision dan Validation, dan **Utama Alan Deta**: Resources, Supervision dan Validation. All authors have read and approved the final version of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors state that Generative Artificial Intelligence and other assistive technologies were not used excessively in the research and writing process for this paper. Specifically, ChatGPT was used for brainstorming ideas, Grammarly for grammar and style correction, and Scite for analyzing citation context. The authors have reviewed and edited all AI-generated content to ensure accuracy, completeness, and compliance with ethical and scientific standards, and are fully responsible for the final version of the manuscript.

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