Journal of Information Systems Engineering and Management
2025, 10(28s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Model of the JR Smash Target Table Tennis Tool (JR Smash Target)

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ARTICLE INFO

Received: 18 Dec 2024

Revised: 10 Feb 2025

Accepted: 28 Feb 2025

ABSTRACT

One of the technologies used in table tennis is the target smash sensor technology. However, the cost of such sensors is generally considered to be relatively high. This study aims to: (1) develop the design of a product (JR Smash Target-2023) for drill training in smash techniques, and (2) produce an effective and affordable product (JR Smash Target-2023). Using research and development methods, the findings indicate that the product quality of the JR Smash Target-2023 was rated as "Excellent" by the first material expert, with a score of 83. The evaluation by the second material expert (Coach) also resulted in an "Excellent" rating with a score of 85. The electronic expert's evaluation rated the product as "Excellent" with a score of 89. The conclusions are: (1) the JR Smash Target-2023 model can be effectively used as a training aid for smash technique drills, and (2) it is an effective tool for assisting in smash technique drills. It is recommended that the JR Smash Target-2023 be utilized by athletes/players of all levels due to its affordability.

Keywords: JR Smash Target, Table Tennis Smash, Table Tennis Training, Drive and Spin Techniques, Sports Education

INTRODUCTION

Advances in science and technology are inevitable as society progresses and evolves. These advancements are mirrored in various fields, including sports, where rapid developments are increasingly integrating knowledge from multiple disciplines to enhance performance and training methods. Table tennis is a prime example of a sport that has significantly benefited from these technological and scientific advancements, enjoying widespread popularity among diverse segments of the population. Often played during leisure time, table tennis is not only a source of enjoyment but also provides emotional relief and relaxation. These benefits contribute positively to overall health and well-being. As Biernat et al. (2018) observed, "The belief that exercise is enjoyable can increase the likelihood of prioritizing training sessions within your daily routine and exercising more frequently." This insight highlights the importance of playing sports like table tennis accessible and enjoyable to encourage regular participation. Furthermore, Zagatto et al. (2018) provided a detailed description of table tennis as "a racket sport characterized by intermittent movement patterns, including short rallies interspersed with brief rest periods." This intermittent nature of the game demands a high level of skill and physical conditioning, particularly in executing offensive techniques. Among these techniques, the forehand and backhand drives are critical for successful play. Players aiming to excel in the game must therefore not only refine their forehand techniques but also master their backhand drives, as emphasized by Ren et al. (2019). The execution of a perfect forehand drive, for instance, requires considerable arm muscle strength, as noted by W.-L. Wu et al. (2021). The collective findings from these studies support the assertion that forehand strokes are pivotal in determining the outcome of a table tennis match, particularly as smash strokes play a crucial role in scoring points and gaining an advantage over opponents. Table tennis is classified as a net game, defined as a sport played on a table with a net dividing the playing area, and it utilizes a small celluloid ball that is struck with paddles. According to the Ministry of National Education, as cited by Tomoliyus (2013), and further explained by Verandita Rihtiana (2014), the process of developing table tennis athletes involves multiple, interrelated factors. Effective training programs are built on the foundation of adequate equipment and facilities, efficient and

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well-structured training methods, systematic talent scouting, regular evaluation, sufficient funding, skilled coaches, and well-organized management. Each of these components is essential for nurturing and developing athletes who can perform at high levels of competition.

Observations conducted from June 7 to July 14, 2023, at the PTM Bhineka Table Tennis Club in Sorong City provided valuable insights into the current state and execution of table tennis training at the club. The observations were guided by three key aspects: the implementation of training programs, the availability and quality of facilities, and the overall training environment. Several significant issues were identified that could hinder the effectiveness of training. First, the training process was found to be suboptimal due to the insufficiency of facilities and equipment relative to the number of athletes being trained. The lack of adequate resources meant that not all athletes could receive the necessary attention and training, which could limit their development. Second, the effectiveness of training was compromised by a shortage of ball feeders, which placed an overwhelming burden on coaches. This shortage meant that coaches had to split their attention between feeding balls and providing technical guidance, reducing the overall quality of training. Third, it was observed that many athletes, particularly beginners, were more focused on playing independently rather than engaging in structured training sessions. This independent play, while beneficial for certain aspects of skill development, often led to less effective training, as it lacked the structured guidance necessary for comprehensive skill acquisition. Fourth, athletes' motivation to participate in the training programs was notably low, primarily due to the long waiting times associated with the shortage of equipment and structured coaching. This lack of motivation could negatively impact their overall performance and development. In table tennis, the smash is a fundamental technique where the ball is struck from a high position with speed and power, making it difficult for the opponent to return, as described by Richard (2009). The modern approach to table tennis has increasingly incorporated advanced technology to enhance athletes' performance, with one such technology being the target smash sensor. This technology is invaluable in training, as it provides consistent, precise feeds for high-volume drill sessions, thereby improving athletes' stroke quality and easing the workload of coaches or training partners. Unlike manual drill training, where human error can affect the consistency and accuracy of ball feeds, sensor technology significantly reduces the potential for such errors, ensuring a more effective training session. Moreover, players training independently without the benefit of a sparring partner greatly benefit from the precision and reliability offered by these sensors. However, it is important to note that the cost of these target smash sensors remains prohibitively high, with prices ranging from 3 million to 10 million IDR or more. This high cost poses a barrier to widespread adoption, particularly in clubs with limited budgets. In light of these considerations, the research problem was formulated as follows: (1) How can a simple smash target device (JR Smash Target-2023) be developed to facilitate drill training for smash techniques in table tennis? (2) Is the JR Smash Target-2023 an effective tool for drill training in smash techniques? The objectives of this development research are twofold: (1) to develop a simple, yet effective design for the JR Smash Target-2023 specifically for smash technique drill training, and (2) to create a reliable and efficient JR Smash Target-2023 that enhances athletes' smash technique skills in table tennis.

METHODS AND METHODOLOGY

Methods

The method employed in this study is the research and development (R&D) approach, which is particularly suited for creating and refining innovative products through a systematic process. This study's development procedure was meticulously structured into several critical stages to ensure the successful creation and implementation of the product. These stages included: (1) identifying potentials and problems, which involved a thorough analysis of the existing gaps and opportunities within the context of table tennis training; (2) data and information collection, where comprehensive data were gathered from various sources to inform the design and development process; (3) product design, which involved the conceptualization and creation of the initial prototype based on the collected data; (4) design validation, where the prototype was evaluated against set criteria to ensure it met the desired objectives; (5) design revision, which involved making necessary adjustments based on the validation feedback; (6) product testing, where the revised prototype was subjected to real-world testing conditions to assess its performance; (7) product revision, following the initial testing, to refine and improve the prototype further; (8) usage testing, where the product was tested in a more extensive, practical setting to gather additional insights; (9) product revision, based on feedback from the usage testing, ensuring the product met all required standards; and (10) mass production, where the final

version of the product was prepared for broader dissemination and use. The design of this developmental research was grounded in an experimental framework, specifically tailored to facilitate rigorous testing and refinement of the product. The testing process was divided into two distinct stages: a small group trial, which involved six novice athletes to gather preliminary data and insights, and a large group trial, which included fifteen novice and junior athletes from PTM Bhineka in Sorong City. These trials were essential for collecting the critical information necessary for making informed revisions to the product.

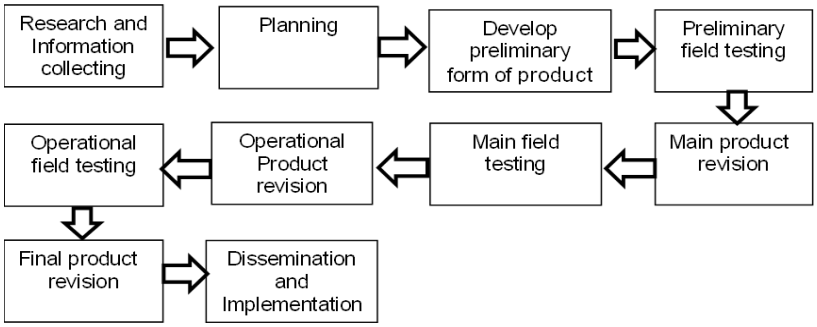

Figure 1. Steps in the Smash Training Model. (Borg & Gall, 1989)

Methodology

The research and development developed (Borg & Gall, 1989) was initially for the benefit of the industrial world, but as development progressed, this research and development model was adopted and used in the research world. The following are the 10 development steps used:

The study involved a diverse group of subjects to ensure comprehensive data collection and analysis. The participants included: (1) seven novice table tennis athletes who participated in the small group trial, providing initial feedback on the product's usability and effectiveness; (2) fifteen junior table tennis athletes who took part in the large group trial, offering more extensive data for analysis; (3) an electronics expert who contributed specialized knowledge on the technical aspects of the product, ensuring its reliability and functionality; (4) a table tennis academic (lecturer) who provided theoretical insights and ensured the product's alignment with educational and training objectives; and (5) a table tennis practitioner/coach who brought practical experience and expertise, offering valuable input on the product's applicability in real-world training scenarios. The research utilized both qualitative and quantitative data to provide a well-rounded evaluation of the product. Qualitative data were primarily gathered through interviews, which allowed for the collection of detailed feedback and suggestions from the expert teams. This feedback was provided both verbally and in writing, offering constructive input that was critical for making informed revisions to the product. Quantitative data, on the other hand, were derived from the evaluation of the tool's effectiveness, providing measurable outcomes that could be analyzed to determine the product's success in achieving its objectives. The instruments used for data collection were carefully selected to ensure the accuracy and reliability of the information gathered. These included interviews, which were systematically conducted to gather in-depth insights from experts; questionnaires, which were distributed to expert teams, including lecturers and table tennis coaches, to assess the product's quality and effectiveness; field observations, which provided real-world data on the product's performance; and documentation, which ensured that all findings were accurately recorded and available for analysis. The data analysis process was thorough and systematic, involving several key steps: (1) gathering all observational data, including field notes, interview notes, and discussion records, to ensure a comprehensive dataset; (2) conducting an initial analysis to categorize the data into relevant themes, with the first category focusing on product refinement and the second on the product's effectiveness and the achievement of its objectives; (3) performing a secondary analysis within each category to delve deeper into the data, with the first analysis identifying supporting data for product refinement and the second mapping the product's effectiveness and its success in meeting its objectives; (4) synthesizing the data, which involved processing and integrating all the information collected to formulate a clear picture of the product's final achievement; and (5) drawing final conclusions, where the overall findings were summarized and presented, providing a clear and concise overview of the research outcomes.

RESULTS

The development research undertaken in this study has successfully culminated in the creation of the final product, a simple yet effective smash target device (JR Smash Target-2023), which is specifically designed to facilitate drill training for smash techniques in table tennis. This product was developed with the primary aim of addressing the needs of athletes, particularly those at the novice and junior levels, by providing them with a practical and reliable training tool. The effectiveness of this device was measured through a series of well-structured evaluations and trials, which were conducted to ensure that the product met the intended training objectives. The success indicators of this tool were multifaceted, encompassing both qualitative and quantitative aspects, including the evaluation scores provided by expert teams who rigorously assessed the device's performance, as well as the results obtained from effectiveness trials that tested the product in real-world training environments. These indicators collectively demonstrate the product's viability as a training aid that can significantly enhance the technical skills of table tennis players.

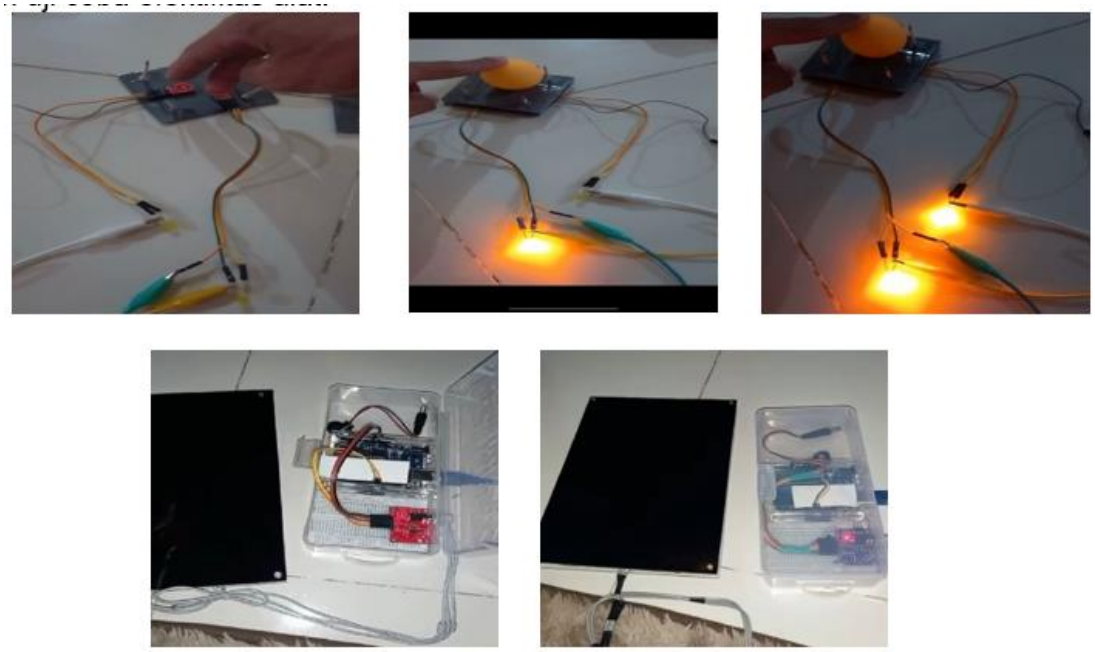

Figure 2. Tool JR Target Sensors (As, 2023)

The evaluation process involved a detailed and systematic assessment by several experts, each focusing on different aspects of the product's overall quality. The first expert (Expert I) conducted a comprehensive evaluation across all relevant aspects of the device, resulting in a rating of "excellent" with a score of 83. This rating reflects the expert's recognition of the product's high-quality design and functionality. Similarly, the second expert (Expert II) provided an evaluation that also concluded with an "excellent" rating, this time with a slightly higher score of 85, indicating strong confidence in the product's ability to meet the training needs of athletes. Furthermore, an evaluation conducted by an electronics expert, who focused specifically on the technical aspects of the device, yielded an "excellent" rating with an even higher score of 89. This score underscores the product's robust engineering and reliability, particularly in its electronic components, which are critical for its operation. In addition to these expert evaluations, the researchers also conducted detailed interviews during the small-scale trial phase, which involved six novice table tennis athletes from PTM Bhineka in Sorong City. These interviews provided valuable insights into the user experience and highlighted areas for potential improvement, the details of which are summarized in Table 1. Based on the feedback gathered from these interviews, the researchers made necessary revisions to the simple smash target device (JR Smash Target-2023), which are documented in Table 2. Following these revisions, the product was subjected to a large-scale trial involving a broader group of athletes. To further assess the effectiveness of the device, the researchers conducted additional interviews with these athletes, gathering comprehensive data on the product's performance in a more diverse training context. The results of the interviews with junior athletes during the large-scale trial are presented in Table 3 following:

Table 1. Results of Interviews with Novice Athletes during the Small-Scale Trial

Substance	Interview Results with Novice Athletes						Conclusion
	1	2	3	4	5	6	
Comfort	*	*	*	*	*	*	Product comfortable
Safety	*	*	*	*	*	*	Product safe
Usefulness for drill training	*	*	*	*	*	*	Product can be used for future training
Ease of operation	*	*	*	*	*	*	Product is easy to operate
Assisting in replacing the coach's role in drill training	*	*	*	*	*	*	Product can be used as an alternative to replace the coach's function in drill training

Table 2. Results of Product Revisions after the Small-Scale Trial

Revised Section	Revision Results	Purpose
Target size	The smash target was enlarged to approximately 30 x 30 cm	To facilitate the determination of the smash target

Table 3. Results of Interviews with Junior Athletes during the Large-Scale Trial

Substance	Interview Results with Junior Athletes					Conclusion
	1	2	3	4	5	
Comfort	*	*	*	*	*	Product comfortable
Safety	*	*	*	*	*	Product safe
Usefulness for drill training	*	*	*	*	*	Product can be used for future training
Ease of operation	*	*	*	*	*	Product is easy to operate
Alternative replacement for the old training method in smash	*	*	*	*	*	Product can be used as an alternative for smash drill training

Meanwhile, Table 4 provides an in-depth analysis of the results obtained from interviews conducted by the researchers during the large-scale trial involving 10 novice-level table tennis athletes. This table is crucial in understanding the overall effectiveness of the simple smash target device (JR Smash Target-2023) as observed throughout the study. The comprehensive evaluation of the device's effectiveness during this large-scale trial covered several critical aspects, each contributing to a holistic assessment of the product's performance. These aspects included the efficiency of the ball feeds and drills facilitated by the device, the conservation of energy during training sessions, and the optimal use of the available training space. Through these lenses, the simple smash target device (JR Smash Target-2023) demonstrated substantial effectiveness as a training aid, particularly for practicing drive and spin stroke drills. This effectiveness was evidenced through a meticulous comparison of the number of successful shots and the accuracy of drill feeds between training sessions using the simple ball launcher (JR Smash Target-2023) and those conducted without the device, relying instead on a human partner or coach for ball feeding. The results clearly indicated a favorable outcome when using the JR Smash Target-2023. There was a significant increase in the number of successful shots and a marked reduction in feed errors. This notable improvement can be directly attributed to the consistent and precise feeding mechanism that the device provides, which effectively minimizes human error and enhances the overall efficiency of the training sessions. Such consistency is particularly beneficial in creating a controlled training environment where athletes can focus on honing their skills without the variability introduced by human feeders.

During trials that involved 125 balls with 5 junior athletes, the JR Smash Target-2023 demonstrated exceptional reliability, with no errors recorded in successful hits. This performance underscores the device's precision and consistency, which are critical factors in ensuring that the athletes receive uniform training conditions, thereby maximizing the effectiveness of each session.

Table 4. Interview Results with Novice Athletes in the Large-Scale Trial

Substance	Hasil wawancara terhadap atlet pemula										Kesimpulan
	1	2	3	4	5	6	7	8	9	10	
Comfort	*	*	*	*	*	*	*	*	*	*	Product comfortable
Safety	*	*	*	*	*	*	*	*	*	*	Product safe
Usefulness for drill training	*	*	*	*	*	*	*	*	*	*	Product can be used for future training
Ease of operation	*	*	*	*	*	*	*	*	*	*	Product is easy to operate
Alternative replacement for the coach	*	*	*	*	*	*	*	*	*	*	The product can be used as an alternative replacement for the coach in drill training

Similarly, when tested with 10 novice athletes using 50 balls, the device's sensor system operated flawlessly. This further confirms its dependability across various training scenarios and with different levels of athletes. The ability of the JR Smash Target-2023 to maintain its performance across these trials indicates that it is a robust tool capable of delivering consistent results, regardless of the specific demands of the training session. Moreover, the effectiveness of the JR Smash Target-2023 was also clearly demonstrated in its contribution to more efficient training sessions, particularly in terms of space utilization. The thoughtful design of the device allows it to be strategically placed at various points on the table, whether near the net, in the middle, or at the back of the table, depending on the specific needs of the training session. This flexibility is invaluable, as it not only facilitates targeted training but also significantly simplifies the coach's role in monitoring and assessing the athletes' progress towards achieving their training objectives. By enabling precise placement of the sensor, the JR Smash Target-2023 ensures that athletes can focus on developing specific smash techniques with greater accuracy, leading to more productive and effective training sessions. Additionally, the practical design of the device, which allows for easy assembly and disassembly, enhances its convenience for both coaches and athletes. The ability to quickly adjust the device to suit different training environments further contributes to its practicality and widespread applicability in various training contexts. This adaptability makes the JR Smash Target-2023 a versatile and essential tool for table tennis training, particularly in settings where consistency and precision are paramount.

DISCUSSION

Based on the thorough validation conducted by the expert team on the initial design of the simple smash target device (JR Smash Target-2023), several critical recommendations were put forth with the objective of significantly enhancing both the quality and functionality of the product, thereby ensuring it meets the high standards expected in a rigorous training environment. Firstly, the expert team strongly advised replacing the current wooden frame or support structure with wood of higher quality and greater durability, as the initial choice of materials, while functional, was deemed insufficient for long-term use, particularly in conditions involving frequent and intense operation. This recommendation was rooted in the observation that the original design, which relied heavily on nails for securing the wooden components, could potentially lead to instability or wobbling during use, thereby compromising the device's reliability and precision. To address this concern, the experts suggested a structural modification that involved the incorporation of bolts to reinforce the connections, thereby providing a more secure and stable assembly that would better withstand the mechanical stresses associated with regular training sessions. Secondly, the team identified the size and arrangement of the cables as another crucial area in need of improvement. The original cables, although functional, were found to be insufficiently robust for the demands of the device, which could lead to potential issues such as short circuits or mechanical failure. As a solution, the experts recommended upgrading to larger, more robust cables that could handle higher electrical loads and resist wear and tear over time. Additionally, they suggested reorganizing the cable layout to ensure a tidier and more secure arrangement, particularly by enclosing the joints with sockets, which would not only enhance the overall safety of the device by reducing the risk of short circuits but also make it more practical and user-friendly in terms of assembly and disassembly. This improvement is especially important for ensuring that the device can be quickly and efficiently set up or taken down, which is a critical consideration in dynamic training environments where time and efficiency are of the essence. Finally, one of the most significant functional enhancements proposed was the addition of at least two directions for the ball's release, specifically to the right and left, which is a crucial feature given the nature of table tennis, a sport that demands high levels of mobility and quick reflexes from its players. By allowing the device to release balls in multiple directions, the JR Smash Target-2023 would more accurately simulate real-world playing conditions, where the ball's trajectory is unpredictable and varied. This feature would not only make the device a

more versatile training aid but also serve as an effective tool for improving footwork, as athletes would be required to move quickly and efficiently across the table to respond to the ball's changing direction. In summary, these recommended enhancements—ranging from structural modifications to functional improvements—are aimed at significantly improving the JR Smash Target-2023, making it a more robust, reliable, and effective tool for table tennis training at all levels.

CONCLUSION

Based on the comprehensive research findings and subsequent discussion, several significant conclusions can be drawn, all of which underscore the successful development and practical utility of the simple table tennis smash target device (JR Smash Target-2023). First and foremost, the JR Smash Target-2023 has been effectively developed as a straightforward yet highly functional training aid specifically designed for practicing drive and spin techniques, making it particularly beneficial for novice and junior table tennis athletes who are in the early stages of skill development. The device's effectiveness as a drill training tool has been clearly demonstrated through its ability to provide high accuracy in feeding multiple balls, which is critical for refining these essential techniques. In terms of energy efficiency, the JR Smash Target-2023 significantly contributes to reducing the physical effort required by coaches during training sessions, thereby allowing them to focus more on providing strategic guidance rather than manual ball feeding. This reduction in physical exertion not only enhances the coach's ability to deliver quality training but also ensures that the sessions are conducted more efficiently. Furthermore, from a spatial perspective, the JR Smash Target-2023 exhibits remarkable versatility. It is designed to be easily assembled and disassembled, allowing for quick setup and takedown, which is particularly advantageous in dynamic training environments. Moreover, the device can be positioned at various strategic points on the table according to the specific needs of the training session, whether it be near the net, in the middle, or at the back of the table. This flexibility in positioning enhances the effectiveness of the training by enabling targeted practice on different areas of the table, thus simulating a variety of match scenarios. Several recommendations are offered to optimize the utilization of this product. Firstly, the JR Smash Target-2023 is both accessible and affordable, making it an ideal training tool for players and athletes across all levels, from beginners to more advanced players. Its affordability ensures that it can be widely adopted without placing a significant financial burden on users. Secondly, for table tennis clubs that emphasize skill development, particularly for novice and junior players, this training aid comes highly recommended. Its proven effectiveness in supporting performance improvement makes it a valuable addition to any training regimen, helping young athletes to develop the foundational skills necessary for competitive play. Lastly, coaches and physical education teachers are encouraged to consider adapting or further refining the JR Smash Target-2023. By doing so, they can develop additional training tools that could complement the existing device, thereby creating a more comprehensive and effective training program that enhances overall performance in table tennis. These recommendations are aimed at maximizing the benefits of the JR Smash Target-2023, ensuring that it remains a relevant and valuable tool in the ongoing effort to improve table tennis skills at all levels of play.

Acknowledgement

This research was conducted as part of the requirements for completing the Doctoral Program in Sports Education at the Graduate Program of Universitas Negeri Jakarta, Indonesia. The publication of this research article was fully supported by the Education Fund Management Institution, Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia (BPI KEMENDIKBUDRISTEK RI). The researcher also extends the highest appreciation and gratitude to all individuals and institutions who contributed to the preparation of this research and the publication of this article.

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