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RESEARCH ARTICLE

Feasibility Study of Technology Footwork Ability Test on National Disability Badminton Athletes

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Abstract
Technological advances in sports testing and measurement are expanding, but there is a notable gap in research focused on physical conditioning tests for athletes with disabilities. This study aims to evaluate the effectiveness of footwork ability test technology for para badminton athletes. A quantitative descriptive design was employed, involving trials with both the footwork ability test technology and conventional methods. The subjects were National Para Badminton Athletes of Malaysia, selected through purposive sampling for their relevance to the research objectives. The study utilized a footwork ability test device, whose validity and reliability were assessed in comparison to conventional tests. Data were analyzed using percentage calculation techniques to determine effectiveness and error rates. Results indicate that the footwork ability test technology achieved an effectiveness rate of 97.1%, demonstrating superior performance with a lower error rate than conventional tests. This indicates the technology's suitability for athletes with disabilities, including those categorized as lower standing, upper standing, and short stature. The findings suggest significant potential for broader application in various sports disciplines. Future research should explore the technology's adaptability to different sports and environmental conditions, contributing to more inclusive and advanced training methodologies for athletes with disabilities.

Keywords
Athletes, Badminton, Disability, FootWork, Sports Technology

INTRODUCTION

Technological developments today are very complex and permeate all areas of life. In the correct terms, technology refers to all efforts to solve human problems. It means organizing people, events, and machines using knowledge and proven tools, procedures, and techniques (Donthu et al., 2021; Hoehe & Thibaut, 2020; Holland & Bardoel, 2016). The surge of modern technology isn't just for our gadgets and gizmos, it's also revolutionizing the world of sports. Technological advancements are proving to be game-changers in enhancing athletic across the board (Faraidoon Habibi & Mohammad Omid Khairandish, 2023; Haake, 2009).

This exciting link between science and sports achievement, as point out, isn't just for elite athletes (Di Domenico et al., 2019; Stovba et al., 2020; Wilson & Clayton, 2010). Technology is democratizing performance optimization, making it accessible not only to professionals but also to amateur and even disabled athletes (Pramantik & Burhaein, 2019; Rum et al., 2021). The concrete examples of technology have demonstrated significant optimization, particularly in the context of badminton.

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This technology not only aids athletes in refining their techniques but also enables them to surpass previous limitations especially in badminton. Smart sensor systems analyze footwork and swing patterns, empowering athletes to perfect their techniques and push boundaries (Lourenço et al., 2024; Soares, Mollo Tormin, Carvalho, & Alves, 2024). The utilization of visual reaction training systems has also shown positive impacts on the evaluation and monitoring of performance among disabled athletes (Kuo et al., 2022). Biomechanical analyses provide insights into techniques that athletes can utilize for evaluation or feedback for improvement (Purnama & Doewes, 2022). Monitoring vital signs and fatigue levels, optimizing training regimens, and analyzing performance data become more accessible and accurate with this technology (Erick et al., 2024; Rum et al., 2021). With the aid of technology, disabled athletes can reach peak performance and compete at the highest levels, fostering greater inclusion in the sports realm. Thus, technology not only creates wonders in the world of sports but also opens doors for broader advancements, wider inclusivity, and higher performance achievements for all athletes..

Although technology holds immense potential to improve badminton performance for athletes with disabilities, its utilization in this area lags behind (Williyanto et al., 2023). This underutilization is especially evident in the lack of specialized testing and training tools tailored for their needs (Jurczak et al., 2018). Despite this gap, existing research shows that technology can significantly enhance physical and technical aspects in disabled badminton players (Berardi et al., 2021). Therefore, bridging this technology gap through developing and implementing accessible tools and training methods is crucial to unlock the full potential of disabled athletes in the badminton world.

To achieve success, basic badminton techniques are essential for players to master to play well (Rifai et al., 2020). Basic footwork techniques are essential to increasing agility in badminton games (Donie et al., 2023; Malwanage et al., 2022). Footwork techniques are among the most essential skills to master in badminton games (Shedge et al., 2024; Tan et al., 2023). Footwork tests and exercises have many ways and methods, but they are still conventional, and athletes are bored with these methods (Kuo et al., 2022). Therefore, new methods or methods are needed so that athletes have new motivation and enthusiasm for the footwork test, one of which is using technology (Fang & Sun, 2021). Based on FGDs conducted with badminton coaches with disabilities, it turns out that in the footwork test process, they still use the old method, which can be said to be invalid, and there is no parameter technology for measuring practical tests, especially for athletes with disabilities.

The actual footwork test can be varied using technology to maximize the results (Li, 2020). As is the case in badminton, there is already a footwork ability test technology, which is a tool that can facilitate the player's footwork test activities, where initially, it was only manual calculations . However, now this technology can detect footwork movements made by athletes through an embedded camera so they can see the results—score on the footwork test. Several similar studies have been conducted, data was obtained showing an increase in agility caused by the treatment of footwork technology training (Kuo et al., 2020; Yousif & Yeh, 2011). This research shows that technology has a good impact on increasing agility training in badminton athletes. Studies explored the promising potential of electric motor-powered training aids for athletes with disabilities, focusing on boccia players at the Pelatnas training center (Prabowo et al, 2021). The next one is a research from (Fahira et al., 2023), she has implemented a footwork ability test device on athletes with disabilities in Bandung. In his research, Raihan successfully used the test kit, which has been proven effective for mild disabilities at lower standing numbers. While their prototype demonstrated the feasibility of integrating technology into training tools, its heavier weight compared to manual tools presented a limitation that impacted its effectiveness. However, it has not been tested with more severe levels of disability. Therefore, this research aims to conduct a feasibility study of footwork ability test technology in badminton athletes, focusing on its application for disabled Malaysian badminton players. The study will assess the effectiveness of this technology in measuring and analyzing their footwork skills in these specific categories, providing valuable insights for developing tailored training programs and promoting inclusivity in Malaysian badminton.

MATERIALS AND METHODS

Research Design

This study uses a quantitative descriptive research design. Descriptive research aims to describe circumstances, situations, events, and others (Creswell & Creswell, 2018; Jack Fraenkel et al., 2018). Data analysis techniques use percentage calculations.

Participants and Instrument

The participants of this research is the National Para Badminton Athlete of Malaysia. The sampling technique uses a purposive sampling technique in which the researcher determines sampling by establishing unique characteristics of the research objectives. The research subjects were athletes with disabilities in badminton who were proficient and attended training. In this study, the instrument used was footwork ability test technology, a tool to measure agility through testing tools in conducting footwork tests.

Table 1. Gender, Age, Height, Weight & BMI Partcipant

Gender	Age	Height	Weight	BMI
L	26	171	69	23.6
L	24	168	68	24.4
L	25	170	65	22.5

The average age of the participants in the study is 25 years, with a standard deviation of 1 year, indicating that there is little variation in age among the participants. The average height is 169.67 cm, with a standard deviation of 1.53 cm, while the average weight is 67.33 kg, with a standard deviation of 2.08 kg. The average Body Mass Index (BMI) of the participants is 23.5, with a standard deviation of 0.95. These data suggest that the participants have relatively homogeneous physical characteristics, which is important for ensuring the consistency of the research findings.

Research is carried out strictly, then Security and welfare. Participants are given priority during study design and implementation and Steps are taken to ensure data confidentiality. Permission to conduct research was obtained from Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1214/UN40.A6/KP/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Figure 1. Footwork ability test

The picture above shows that the sample performs a footwork test using technology and a manual. The test was carried out in 2 meetings for 60 seconds with two trials, then the amount of footwork contained in the score was recorded according to the results.

Procedure

This research was conducted by applying manual tests and tests with footwork ability test technology devices. The results of the data from calculating the total score of the footwork test are calculated through data analysis of calculating the percentage error value in technology, with the following calculation formula:

Error Percentage Formula:

$$x = \frac{The\ difference\ in\ scores\ with\ and\ without\ test\ equipment}{Score\ count\ without\ tools}\ x\ 100\%$$

Data Collection Procedure

Footwork Test Execution

Participants perform the footwork test, with each participant completing two trials.

Manual Scoring

Examiners manually calculate the footwork test results for each participant.

Data Collection and Preparation

Collect the test results from both the technological device and the manual scoring by the examiners. Prepare the data for analysis to compare the effectiveness and feasibility of the test methods.

RESULTS

The results obtained from the technology trial on three samples of Malaysian National Badminton athletes with disabilities were by doing a footwork test at 2 points, namely the right and left sides. The test was conducted for 60 seconds with two trials using a footwork ability test and a manual test. In

this footwork test tool, the score will appear in the main box with left-right sensor detection, counting the number of steps during the test. The test results can be seen in the Table 1.

Table 2. Footwork Test Data for National Para Badminton Athlete of Malaysia

No	Name	Digital Score	Manual Score	Difference
1	Amyrul Yazid	31	29	2
2	M. Farecz	33	31	2
3	M. Ikhwan	21	18	3
Total Score		85	78	7

The data above is the score acquisition data from the players sampled in the test kit experiment, which is then calculated using the error percentage formula to get the average error data. The data is calculated using the following formula:

$$Percentage\ of\ Errors\ (x) = \frac{7}{78} x\ 100\%$$

$$= \mathbf{8.9\ \%}$$

$$Average\ Percentage\ of\ Error = \frac{8.9\ \%}{3}$$

$$= \mathbf{2.9\ \%}$$

Based on the above calculations, it can be seen that the average error result is obtained for the footwork test with a total error percentage of 8.9% with three athletes as subjects, so the average tool error in the footwork test is 2.9%. The results of the footwork test have an average error because the sensitivity of the tool sensor influences it. When an athlete performs footwork in the wrong direction, the sensor will detect the wrong movement. So it will add numbers to the movement to become a double movement. From the error presentation of the tool that has been tested, the effectiveness of the subject is 97.1%, as illustrated as described in the figure 2. below:

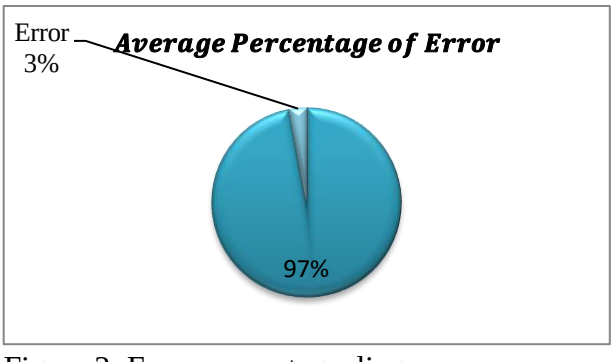

Figure 2. Error percentage diagram

As shown in Figure 2, it can be seen that the percentage of error for the footwork ability test that is applied to athletes with elite disabilities reaches 3%, so this value is included in the category that can be tolerated and effectively used in athletes with disabilities in badminton. The results showed that the technological device had a high level of accuracy, with an effectiveness rate of 97.1%. This finding provides valuable insights for developing tailored training programs and promoting inclusivity in Malaysian badminton by demonstrating the reliability of using technology to measure athletic performance.

DISCUSSION

The results from our footwork ability test technology trial indicate a generally effective measurement tool for athletes with disabilities in badminton. The average error rate observed was 2.9%, which reflects a minor discrepancy between the digital scores provided by the technology and the manual scores recorded. This small percentage of error is primarily attributed to the limitations of the sensor in detecting certain footwork movements accurately. When athletes performed movements that did not align perfectly with the sensor's detection points, the device occasionally misinterpreted these as excessive steps, leading to slight inaccuracies in the recorded scores. Despite these challenges, the overall performance of the footwork ability test technology remains promising, with a high effectiveness rate of 97.1%. The observed discrepancies highlight an important consideration in the use of such technology: the sensor's ability to accurately detect and record footwork movements can be influenced by the athlete's movement patterns. The technology's detection algorithm may not fully accommodate the variability in footwork, especially if the movements deviate significantly from the expected patterns. This limitation is a crucial point for further refinement of the technology to enhance its accuracy and reliability.

Beyond just footwork assessment, it is envisioned that the findings of this research can transcend specific techniques and contribute to wider advancements in badminton and athletic training as a whole. As we know, footwork is a crucial aspect of badminton that can be trained under actual match conditions; this is in line with the opinion by Ngadiman et al., (2020), he states that footwork is a technique that a reliable badminton player must master. By shedding light

on the effectiveness of footwork ability test technology, we aspire to ignite a spark of innovation across various sporting disciplines (Simbolon et al., 2023). Similar to how technology revolutionizes education by facilitating easier learning and driving progress (Mormina, 2019; Rongping & Wan, 2008), we hope this research paves the way for novel training methodologies and technological advancements in sports. Imagine a future where athletes have access to a diverse array of data-driven insights, empowering them to optimize their performance and push the boundaries of human potential. Through rigorous research and the responsible integration of technology, we can unlock a new era of sporting excellence, fostering not only a deeper understanding of athletic movement but also inspiring the next generation of sports tech innovations.

While research demonstrates the immense potential of footwork ability test technology in badminton, several factors require further consideration for broader application. One key limitation relates to the current environmental constraints. As noted by (Seçkin et al., 2023), these tools are primarily designed for indoor settings like sports halls. Their use in outdoor spaces faces challenges, particularly during rainy weather. Moisture can damage sensitive electronic components, and rain droplets can interfere with the accuracy of light sensor readings, impacting data collection and analysis (van der Kruk & Reijne, 2018). Addressing these limitations necessitates further research and development. Optimizing sensor technology for weatherproof functionality would be crucial, as highlighted by previous research, in their study on outdoor training tools (Zhang et al., 2022). Alternative sensor types less susceptible to environmental factors could also be explored. Additionally, designing durable equipment casings capable of withstanding moisture and outdoor conditions is essential for ensuring tool longevity and reliability. Overcoming these challenges would unlock the potential for wider access to footwork ability test technology. Athletes training outdoors or in regions with unpredictable weather patterns could benefit from objective performance assessments and data-driven training guidance. Ultimately, by fostering further research and development aimed at environmental adaptability, we can pave the way for a future where footwork ability test technology empowers badminton athletes regardless of location or weather conditions.

In summary, this research underscores the potential of integrating technology into athletic training and highlights the need for ongoing refinement to address environmental and practical challenges. By advancing these technologies, we can enhance performance assessments and support athletes in achieving their full potential, paving the way for innovative training methodologies and fostering advancements across various sports disciplines.

Conclusion

Our research demonstrates the significant potential of footwork ability test technology for national badminton athletes with disabilities. The technology achieved an effectiveness rate of 97.1%, illustrating its capability to accurately measure and enhance footwork skills. This innovative tool caters to various athlete classifications, including standing lower, upper standing, and short stature, making it a versatile solution for diverse needs. The results suggest that this technology can be instrumental in helping both novice and experienced players refine their footwork, thus supporting their journey towards peak athletic performance.

Implication

The successful integration of footwork ability test technology into badminton training programs highlights its potential to transform how athletes with disabilities are coached. By providing accurate, data-driven feedback, this technology enables personalized training that addresses individual needs and improves overall performance. Its inclusivity ensures that athletes across different classifications have equal access to advanced training methods, fostering a more equitable environment in the sport. This could lead to a broader adoption of such technologies in other sports and training contexts, promoting widespread advancements in athletic training.

Limitation

Despite the promising results, the study has some limitations. The footwork ability test technology's accuracy may be affected by specific movement patterns that deviate significantly from the expected sensor points, potentially leading to minor inaccuracies. Additionally, the current design of the technology is optimized for indoor use, and its effectiveness in outdoor settings is limited. Environmental factors, such as moisture and rain, can impact the reliability of the sensors and the

overall data accuracy. These limitations highlight the need for further refinement of the technology to enhance its robustness and adaptability.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this research. The study was conducted independently, and no financial or personal relationships influenced the design, execution, or reporting of the research. The footwork ability test technology used in this study was provided by Universitas Pendidikan Indonesia, but this did not affect the objectivity or integrity of the research findings. All authors have disclosed any potential conflicts of interest, and the study adheres to ethical standards for research and publication.

Ethical Statement

This research was carried out in January 2024. Research ethical approval was obtained from the Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1214/UN40.A6/KP/2024.

Author Contributions

Study Design, MF, RHA, STP, HA,MAR, H; Data Collection, MF, STP, MZ, AS, HA, MAR, H; Statistical Analysis, MF, AS, H; Data Interpretation, MF, AS, H; Manuscript Preparation, MF, RHA, MZ; Literature Search, MF, RHA, MZ. All the authors agreed on the final draft of the manuscript before submitting it for publication.

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