

## Digital Transformation of Sports Testing: A Tablet-Based Assessment Platform for Young Tennis Players

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### ABSTRACT

**Background:** Accurate and efficient management of testing data is essential in youth tennis training. Traditional paper forms and spreadsheet calculations are still widely used but remain time-consuming, error-prone, and difficult to integrate into systematic monitoring. Although digital tools are increasingly adopted in sports science, limited evidence exists on their operational advantages over manual methods in real coaching environments.

**Objectives:** This study evaluated three data-management workflows—(1) manual recording with later Excel entry, (2) direct Excel input, and (3) a web-based automatic platform—implemented at the Srichaphan Tennis Academy. The goal was to compare their accuracy, efficiency, error rate, and user satisfaction during physical-skill assessments of young tennis players.

**Methods:** Twenty players (14 boys, 6 girls; aged 8–12 years) were tested monthly, including before and during a three-month training period (four sessions in total). Three standardized tests were used: zigzag run (agility), push-up test (upper-body endurance), and forehand stroke test (technical skill). Data were entered and analyzed through each workflow by three trained coaches. Efficiency (time per player), transcription errors, and satisfaction (5-point Likert scale) were compared across systems.

**Results:** The web-based platform demonstrated the highest operational efficiency, reducing data-entry and computation time by 58 % compared with manual + Excel recording and by 37 % compared with Excel-only entry. Error rates decreased from 11.5 % (manual) to 4.3 % (Excel) and 0 % (web-based). Overall user satisfaction averaged  $4.7 \pm 0.5$ , with

the highest ratings for ease of use and error-free reporting. All three coaches confirmed smoother workflow and faster feedback generation with the digital platform.

Conclusion: The results confirm that transitioning from paper-based and semi-manual Excel workflows to a fully web-based system markedly improves accuracy, efficiency, and usability in tennis performance assessment. Rather than altering test content, the digital transformation streamlined data handling and eliminated transcription errors. The findings highlight the practical value of digital platforms for modernizing athlete monitoring and supporting evidence-based coaching in youth sport contexts.

**Keywords:** Tennis, Digital assessment, Web-based platform, Data management

## Introduction

Accurate and efficient assessment is essential for evidence-based coaching and systematic athlete monitoring. In tennis, agility, muscular endurance, and forehand accuracy are recognized as key performance indicators (Fernández-Fernández et al., 2014; Ulbricht et al., 2016). While standardized field tests such as the zigzag run, push-up, and forehand stroke assessments are well established, most academies continue to rely on manual paper recording—a process that is time-consuming, error-prone, and difficult to integrate into long term data systems (Baiget et al., 2015). These limitations hinder timely feedback and reduce the practical value of performance testing in daily coaching. Digital transformation in sports testing has emerged as a solution, replacing paper-based forms with computer and mobile applications that simplify data entry, automate calculations, and improve record management. Prior studies have shown that such systems can reduce transcription errors, save time, and enhance usability in various sport contexts (Martínez-García et al., 2020; Khan et al., 2021). More broadly, systematic reviews have shown that mobile-application use enhances efficiency and engagement in sport and health-related physical-activity monitoring. Pradal-Cano et al. (2020) reported that app-based systems facilitate data accuracy, feedback timeliness, and user adherence, supporting the wider adoption of digital platforms for assessment and performance tracking. In tennis, Zhang et al. (2023) validated the SwingVision application for serve analysis, demonstrating strong accuracy in tracking serve speed and placement. Complementary developments include mobile agility-testing tools for

tennis and badminton that achieved results comparable to motion-capture systems (Chiu, et al. 2020) and sensor-based devices capable of quantifying forehand (and other) stroke load and technical parameters with high reliability (Hadžić et al., 2021). Beyond technical monitoring, mobile and tablet-based applications have been successfully applied to evaluate strength and endurance. Silva et al. (2021) confirmed through a systematic review that app-based performance assessments produce results comparable to laboratory standards. Similarly, Moreno-Azze et al. (2025) validated an iOS application (Fitnessmeter) for change-of-direction measurement, showing high consistency with professional timing-gate systems. Collectively, these studies confirm that digital tools can replace manual data entry and computation in field-based sport testing, offering reliable, time-efficient, and user-friendly alternatives.

The present study builds upon this foundation by examining how the integration of a tablet- and web-based platform at the Srichaphan Tennis Academy improves workflow accuracy, efficiency, and usability compared with manual and Excel-based processes—focusing on operational advantages rather than athletic performance outcomes.

## Objectives

1. To develop and implement a tablet- and web-based digital assessment platform at the Srichaphan Tennis Academy featuring a five-page interface for streamlined entry of player information, test results, and automatic data computation.

2. To evaluate young tennis players' physical fitness and technical skills using three standardized assessments: the zigzag run (agility), push-up test (upper-body strength and endurance), and forehand stroke test (technical skill).

3. To compare the operational performance of three data-management workflows—(a) manual recording with subsequent Excel entry, (b) direct Excel input via web-based entry, and (c) the proposed web-based digital platform—in terms of data-entry accuracy, efficiency, and error reduction, based on assessments conducted by the same evaluator.

4. To assess user satisfaction among coaches and evaluators who applied all workflows, determining whether the web-based platform offers a more convenient, reliable, and efficient alternative for recording and analyzing sports-testing data.

## Hypothesis

H1: The integration of a web-based digital assessment platform at the Srichaphan Tennis Academy will significantly improve efficiency and reduce human and transcription errors in recording and processing test results compared with manual + Excel and web-based entry+Excel workflows.

H2: There will be no significant difference in players' measured performance values (agility, push-ups, and forehand accuracy) across the three workflows, indicating that the digital system preserves testing validity while improving data-management accuracy.

H3: Coaches and evaluators will report higher levels of satisfaction with the usability, convenience, and reliability of the web-based platform compared with traditional recording methods.

## Research Scope

This study was conducted with a clearly defined scope, focusing on 20 young tennis players aged 8–12 years from the Srichaphan Tennis Academy. Player performance was evaluated using three standardized assessments: the zigzag run (agility), the push-up test (upper-body strength and endurance), and the forehand stroke test (technical skill). Data collection and computation were examined across three data-management workflows: (a) manual recording with subsequent Excel entry; (b) direct Excel input via web-based entry; and (3) a web-based automatic platform developed for this study. Each workflow was applied by three trained coaches across four testing sessions—one baseline and three monthly follow-ups during a three-month training period—to ensure consistent evaluation and comparison. The primary emphasis of this research was to analyze the accuracy, efficiency, and error reduction achieved by the web-based digital system relative to manual and Excel workflows. The study therefore focused on the technological and operational aspects of digital transformation in sports assessment, rather than on the effects of training program design or long-term athlete development.

## Literature Review

Accurate assessment is fundamental to evidence-based coaching and athlete monitoring. In tennis, agility, muscular endurance, and stroke accuracy are essential for performance (Fernández-Fernández et al., 2014; Ulbricht et al., 2016). Although field tests

such as the zigzag run, push-up, and forehand stroke are widely used, most academies still rely on manual paper forms, which are time-consuming, error-prone, and inefficient for long term data management (Baiget et al., 2015). Digital transformation provides a practical solution. Mobile and web-based systems enable real-time data entry, automatic calculation, and instant feedback. Studies confirm their benefits: Martínez-García et al. (2020) and Khan et al. (2021) reported that digital tools improve accuracy and efficiency, while Zhang et al. (2023) validated the SwingVision app for serve analysis, demonstrating sport-specific feasibility. Likewise, Silva et al. (2021) found that mobile applications for strength assessment achieve reliability comparable to laboratory standards, and Moreno-Azze et al. (2025) confirmed the validity of an iOS agility app equivalent to timing-gate systems. These studies highlight the accuracy and practicality of digital approaches in sport testing. Beyond measurement precision, user experience and workflow design are critical for adoption. Peters et al. (2018) emphasized that intuitive and motivating digital interfaces enhance engagement and satisfaction—principles that underpin the usability evaluation in this study. Building on this evidence, the present work evaluates a web-based platform developed for the Srichaphan Tennis Academy to digitalize the zigzag run, push-up, and forehand-stroke tests for youth players. The study compares three data workflows from manual to semi web-based-application to a fully web-based automation system—to determine which method provides greater accuracy, efficiency, and user satisfaction in real-world sport-assessment practice.

## Methodology

This study employed a comparative quasi-experimental design to evaluate three data-management workflows—manual recording with subsequent Excel entry, direct Excel input via web-based entry, and a web-based automatic platform—focusing on differences in accuracy, efficiency, and error reduction during youth tennis performance assessments.

**Participants:** Twenty players (14 boys, 6 girls; aged 8–12 years) from the Srichaphan Tennis Academy, each with at least six months of training experience, participated in the testing program. Players with injuries or chronic health conditions were excluded. Parental consent and university ethics approval were obtained prior to participation.

**Testing Schedule and Training Context:** Testing was conducted four times in total—at baseline and at the end of each month during a three-month training period. Regular academy training consisted of three 90-minute sessions per week, including warm-up,

technical drills, and conditioning activities emphasizing agility, push-up endurance, and forehand accuracy.

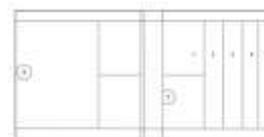
**Performance Assessments:** Three standardized field tests were used: Zigzag Run Test (Agility): Six cones were arranged in a zigzag pattern (4 m spacing, 2 m lateral separation). Time was measured to 0.01 s precision using an integrated stopwatch; Push-Up Test (Upper-Body Endurance): Players performed as many correct push-ups as possible in 30 seconds while maintaining straight posture; only properly executed repetitions were counted; and Forehand Stroke Test (Technical Skill): Players hit ten forehand groundstrokes toward marked target zones. Each stroke was scored from 1–5 points based on accuracy, for a maximum total of 50. Figures 1–3 illustrate the testing setup for each assessment.



**Figure 1.** Set up for zigzag run test



**Figure 2.** Proper form for push-up test



**Figure 3.** Target zone marked for forehand stroke test.

**Workflow Comparison Procedures:** Each of the three workflows was performed by three trained coaches during the same test sessions:

1. Manual + Excel: Results were first written on paper forms and later typed into Excel.
2. Web-based Entry + Excel: Results were entered directly into Excel sheets that required manual formulas for total computation.
3. Web-based system: Results were entered once via the developed online platform, which automatically calculated and summarized outputs.

Each coach completed data entry for all 20 players under all three workflows to ensure consistent comparison. The recorded parameters were data-entry time per player (minutes), transcription or calculation errors (%), and overall satisfaction with each method (Likert 1–5).

**Reliability Procedures:** To ensure reliability, two experienced coaches independently recorded a subset of trials ( $n = 5$  players) during each workflow condition. Inter-rater agreement exceeded 95%. Any discrepancies were reviewed to standardize scoring and data-entry procedures.

**Data Collection and Management:** All performance results and workflow timing data were securely stored on password-protected devices. The web-based system exported results in structured CSV and Excel formats, enabling consistent data comparison across methods. This digital architecture prevented manual transcription errors and allowed for automated analysis.

**Data Analysis:** Descriptive statistics (mean  $\pm$  SD) were calculated for data-entry time, error rate, and satisfaction scores. A one-way ANOVA (ANalysis Of VAriance) was conducted to compare mean efficiency and accuracy among the three workflows. When significant, post-hoc pairwise comparisons identified specific differences. User satisfaction scores were analyzed using descriptive and inferential statistics. The significance level was set at  $p < .05$ .

## Results and Discussion

The primary outcome of this study was the development of an iPad-based digital assessment system designed to record and manage tennis performance test results.

**Page 1:** Player Information Input - as in Figure 4, providing fields for entering player demographic information, including name, age, gender, and relevant health conditions. Drop-down menus and validation checks ensure accuracy and minimized data entry errors. This page serves as the foundation for linking performance data with individual player records.

**(a)**

PHYSICAL FITNESS AND TECHNICAL SKILL OF YOUNG TENNIS PLAYERS  
SRICHAPHAN TENNIS ACADEMY

Player Information:  
First name: \_\_\_\_\_ Last name: \_\_\_\_\_  
Gender:  Male  Female Date of Birth: \_\_\_\_/\_\_\_\_/\_\_\_\_  
Chronic Disease  None  Yes (Pls Specify) \_\_\_\_\_

**(b)**

PHYSICAL FITNESS AND TECHNICAL SKILL OF YOUNG TENNIS PLAYERS  
SRICHAPHAN TENNIS ACADEMY

Player Information	Health Information
Firstname: <input type="text" value="สมชาย"/>	Chronic Disease: <input checked="" type="checkbox"/> None <input type="checkbox"/> Yes
Lastname: <input type="text" value="ใจดี"/>	<input type="text" value="-"/>
Gender: <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female	Weight (kg): <input type="text" value="45"/>
Date of Birth: <input type="text" value="03/15/2010"/>	Height (cm): <input type="text" value="155"/>

**Figure 4.** The sketch (a) and the real UI page (b) for player information input.

**Page 2:** Zigzag Run Test Form - allowing evaluators to enter results of the zigzag run agility test. Time is recorded to two decimal places and automatically stored in the database. A built-in stopwatch function synchronizes with the input field, reducing the need for manual

timing devices and ensuring greater precision. Figure 5 illustrates the draft and the UI of this page and also shows the use of this page in action.

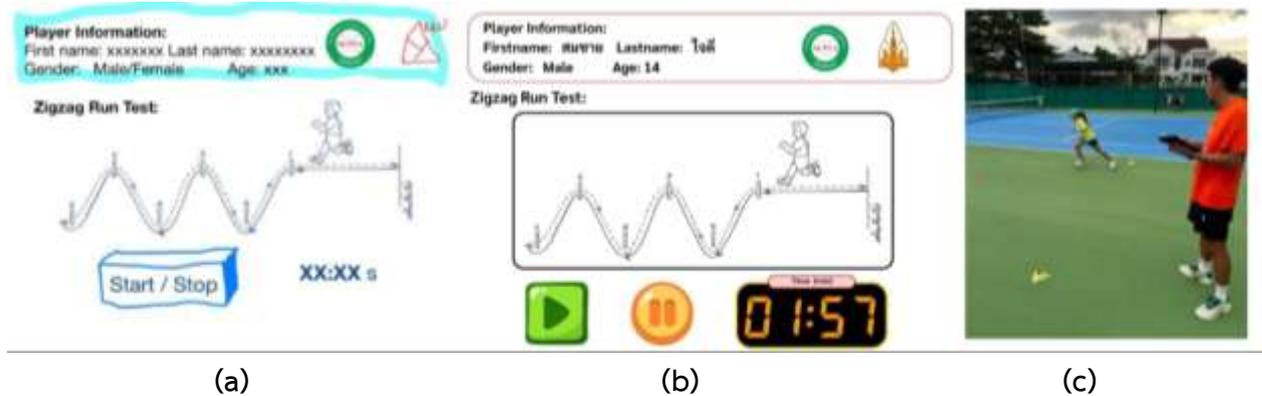


Figure 5. The sketch (a), the UI page (b), and the real use (c) for zigzag run test.

**Page 3:** Push-Up Test Form - enabling entry of the number of correctly performed pushups within 30 seconds. To support consistency, the form includes visual cues describing correct form (e.g., 90-degree elbow bend, straight body posture). The system also features a warning prompt if unusually high or low values were entered, reducing input errors. Figure 6 illustrates the draft and the UI of this page and also shows the use of this page in action.

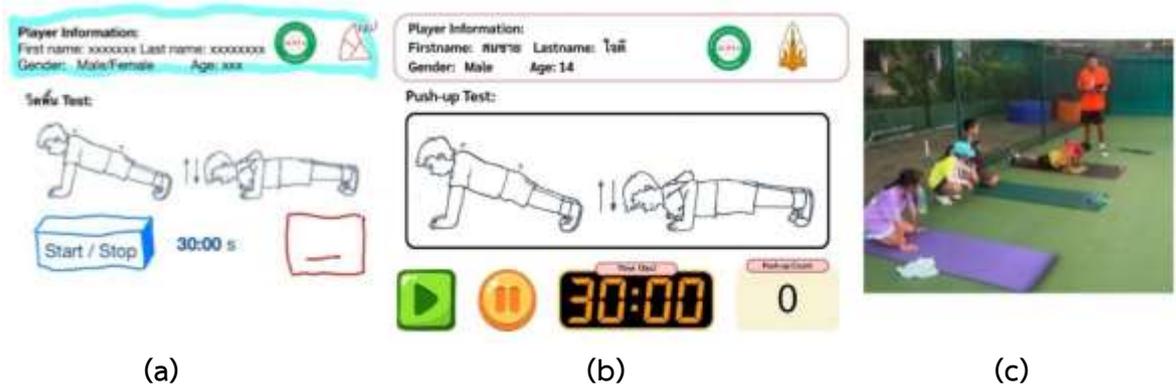


Figure 6. The sketch (a), the UI page (b), and the real use (c) for push-up test.

**Page 4:** Forehand Stroke Test Form - dedicated to the forehand groundstroke skill test. Evaluators record the number of strokes landing in each scoring zone (scores 1–5). The system automatically calculates the total score out of ten attempts, providing immediate

feedback for both coach and player. Figures 7a and 7d illustrates the draft and the UI of this page and also shows the court set up and the use of this page in action.

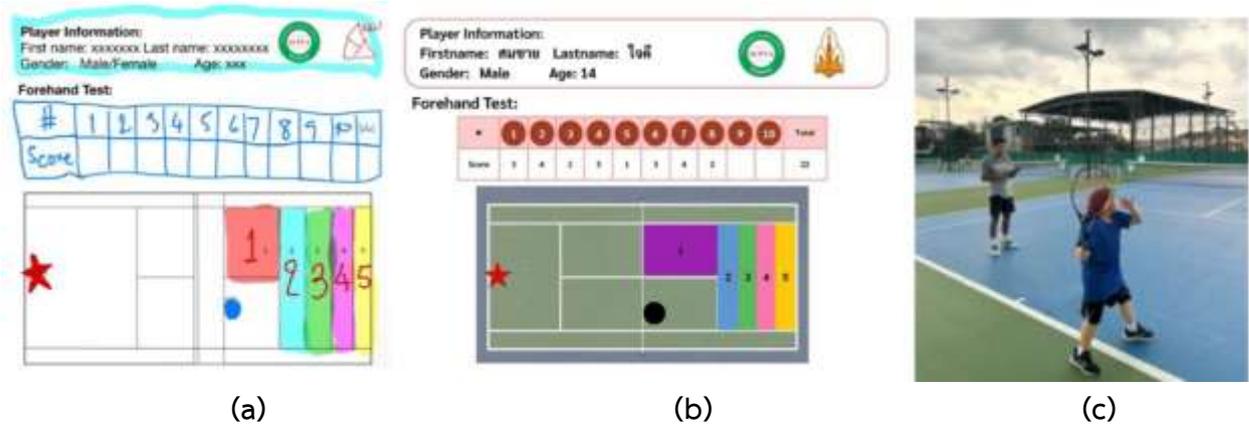


Figure 7. The sketch (a), the UI page (b), and the real use (c) for forehand stroke test.

**Page 5:** Main Summary Page - the main page both for choosing to individual test page and also summarizing all recorded results for each player across the three tests. Figure 8 illustrates the sketch and the UI of this page. Data, then, are automatically formatted and exported into Excel (.xlsx) files with structured columns for statistical analysis. This eliminates manual transcription, reducing time and error risk. The summary view also allows coaches to quickly review individual and group progress.

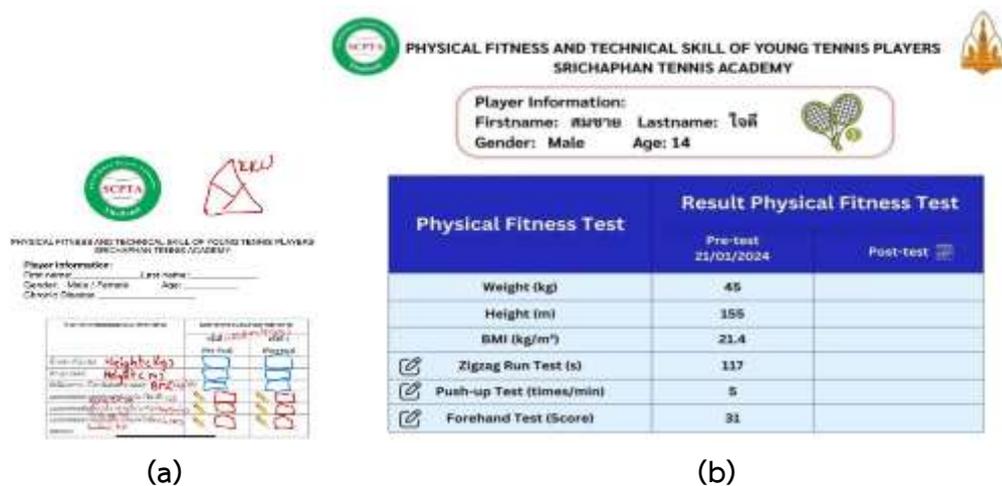


Figure 8. The sketch (a) and the real UI page (b) for the main summary page.

**System Usability and Impact:** The web-based application was designed with a five-page structure that guided evaluators through the entire data-entry and calculation process—from player registration to final report generation. Compared with manual and Excel-based workflows, the web interface provided an integrated and error-checked environment, allowing immediate access to organized datasets. Evaluators noted that the workflow was intuitive, requiring minimal training. The automatic calculation and summary export functions were particularly valuable, as they removed repetitive spreadsheet steps and reduced the risk of manual computation errors.

**System Efficiency:** To determine efficiency gains, data entry and computation were compared across three stages: (1) Manual recording on paper forms with subsequent typing into Excel; (2) Excel via web-based entry workflow, where results were entered directly but still required manual formula setup.; and (3) Web-based automatic system, where data were entered once through the online interface with automatic calculation and report generation. Average time per player was reduced from  $3.6 \pm 0.4$  min to  $2.4 \pm 0.3$  min, and further to  $1.5 \pm 0.2$  min, subsequently, representing an overall 58% reduction in total processing time. Error analysis showed that transcription and calculation errors occurred in 11.5% of manual entries, 4.3% in semi-workflows (mostly formula mislinks), and 0% in the web-based system due to built-in validation and automated computation. These results confirm that the digital platform substantially improved efficiency and accuracy by automating both entry and analysis stages.

**User Satisfaction:** Coach and evaluator feedback indicated strong acceptance of the new system. On a 5-point Likert scale, overall satisfaction averaged  $4.7 \pm 0.5$ , with the highest scores given to ease of use (4.8) and error-free reporting (4.9). Users appreciated the one-step calculation, real-time display of averages, and automatic generation of exportable result sheets. Minor suggestions included adding mobile-optimized views and optional graphic summaries for quick interpretation. Table 1. Compares of data-entry time, error rate, and user satisfaction, showing the progressive improvement from manual entry to fully automated web-based assessment.

**Table 1.** Efficiency and accuracy comparison of three data-management stages.

Workflow Stage	Avg Time / Player (min)	Error Rate (% of entries)	Evaluator Satisfactory (1-5)
Manual + Excel	3.6 ± 0.4	11.5	3.8 ± 0.6
Web-based entry + Excel	2.4 ± 0.3	4.3	4.2 ± 0.5
Web-based System	1.5 ± 0.2	0.0	4.7 ± 0.5

The findings indicate that replacing manual and semi-manual (Excel) workflows with a web-based assessment system can dramatically streamline the evaluation process. Although player-performance tests (agility, endurance, accuracy) remained the same, the data-handling method changed, producing clear operational benefits. The system eliminated transcription errors, halved the total data-entry time, and achieved high user satisfaction—all of which support its practical implementation in coaching and research settings. This aligns with prior literature on the impact of digital tools in improving data reliability and usability in sport testing environments (e.g., Martínez-García et al., 2020; Moreno-Azze et al., 2025).

### Conclusion and Future Work

This study evaluated three data-management workflows—manual + Excel, web-based entry + Excel, and a web-based automatic platform—used for recording and analyzing tennis performance assessments among young players at the Srichaphan Tennis Academy. The results demonstrated that the web-based system provided substantial operational advantages, reducing data-entry and computation time by approximately 58 %, eliminating transcription and formula errors, and achieving the highest user-satisfaction scores among coaches and evaluators. Importantly, while the testing protocols themselves (zigzag run, push-up, and forehand stroke) remained unchanged, the digital platform markedly improved data-handling efficiency and reliability, confirming that technological integration can enhance workflow quality without altering the validity of the physical assessments. Overall, the findings highlight that transitioning from paper-based and semi-manual Excel workflows to a fully automated web-based system can modernize sport-testing management, streamline feedback cycles, and strengthen evidence-based coaching practices in youth tennis environments. Future studies should expand the scope of this comparison by involving multiple academies, larger sample sizes, and additional evaluators to generalize the results across diverse operational contexts. Further development of the platform could include mobile-optimized

interfaces, customizable reporting dashboards, and AI-assisted data analytics for automated performance tracking. Integrating wearable sensor data or video-based analysis could also enhance precision and broaden the application beyond tennis to other racquet and field sports. Finally, long-term evaluations focusing on user adaptation, data security, and system scalability will be valuable for ensuring sustainable digital transformation in sports-performance assessment.

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