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Data driven inclusive sports management: a pilot evaluation of information system usability in para-badminton athlete tracking

Gestión deportiva inclusiva basada en datos: evaluación de la eficacia de los sistemas de información en el desarrollo de atletas de parabádminton

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Abstract

Effective data management plays an important role in supporting the development of inclusive sports, including para-badminton. However, the adoption of information technology in disability sports has not been optimal and still tends to lag behind. This pilot study aims to evaluate the preliminary usability, user-perceived accessibility, and functional adoption of a prototype-based information system adapted for inclusive sports management. The research employed a mixed-methods approach with a one-group pretest-posttest design, involving 30 coaches and para-badminton athletes selected through purposive sampling. Data were collected through a modified questionnaire based on Technology Acceptance Model (TAM) constructs, semi-structured interviews, and direct observations. Quantitative data were validated via Cronbach's alpha (α) and analyzed using descriptive statistics, Shapiro-Wilk normality testing, paired-sample t-tests, and Cohen's d effect size calculations. Qualitative data were evaluated using thematic analysis. The results indicate high user acceptance across core dimensions, including system usability (mean = 4.32 ± 0.45) and training monitoring (mean = 4.40 ± 0.42), with an overall user satisfaction rate of 84%. Inferential metrics revealed significant reductions in perceived administrative recording time ($t(29) = 8.72$, $p < 0.001$, Cohen's $d = 1.59$, 95% CI [1.08, 2.10]) and positive shifts in perceived data accessibility ($t(29) = 9.15$, $p < 0.001$). Qualitative insights highlighted enhanced structural transparency alongside infrastructural barriers. While the lack of a control group limits direct causal assertions regarding actual athletic development, the findings conclude that implementing an adaptive web platform modeled after the Sistem Informasi PBSI ecosystem (<https://si.pbsi.id/>) offers a viable, user-centered framework for digitalizing adaptive sports administration.

Keywords: inclusive sports; information systems; para-badminton; sports management; digital transformation

Resumen

La gestión eficaz de datos desempeña un papel fundamental en el desarrollo de deportes inclusivos, incluido el parabádminton. Sin embargo, la adopción de tecnologías de la información en el deporte adaptado no ha sido óptima y aún tiende a estar rezagada. Este estudio piloto tiene como objetivo evaluar la usabilidad preliminar, la accesibilidad percibida por el usuario y la adopción funcional de un sistema de información basado en un prototipo adaptado para la gestión de deportes inclusivos. La investigación empleó un enfoque de métodos mixtos con un diseño pretest-posttest de un solo grupo, en el que participaron 30 entrenadores y atletas de parabádminton seleccionados mediante muestreo intencional. Los datos se recopilaron mediante un cuestionario modificado basado en los constructos del Modelo de Aceptación de la Tecnología (TAM), entrevistas semiestructuradas y observaciones directas. Los datos cuantitativos se validaron mediante el alfa de Cronbach (α) y se analizaron utilizando estadística descriptiva, la prueba de normalidad de Shapiro-Wilk, pruebas t de muestras pareadas y cálculos del tamaño del efecto d de Cohen. Los datos cualitativos se evaluaron mediante análisis temático. Los resultados indican una alta aceptación por parte de los usuarios en las dimensiones principales, incluyendo la usabilidad del sistema (media = $4,32 \pm 0,45$) y el monitoreo de



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la capacitación (media = $4,40 \pm 0,42$), con una tasa general de satisfacción del usuario del 84%. Las métricas inferenciales revelaron reducciones significativas en el tiempo percibido de registro administrativo ($t(29) = 8,72$, $p < 0,001$, d de Cohen = 1,59, IC del 95% [1,08, 2,10]) y cambios positivos en la accesibilidad percibida de los datos ($t(29) = 9,15$, $p < 0,001$). Las perspectivas cualitativas destacaron una mayor transparencia estructural junto con barreras infraestructurales. Si bien la falta de un grupo de control limita las afirmaciones causales directas con respecto al desarrollo atlético real, los hallazgos concluyen que la implementación de una plataforma web adaptativa modelada a partir del ecosistema Sistem Informasi PBSI (<https://si.pbsi.id/>) ofrece un marco viable y centrado en el usuario para digitalizar la administración de deportes adaptados.

Palabras clave: deportes inclusivos; sistemas de información; parabádminton; gestión deportiva; transformación digital

Introduction

Inclusive sports represent a crucial pillar in social development oriented toward equality and justice for all individuals, including persons with disabilities. In recent years, global attention toward disability sports has increased significantly, particularly since the inclusion of para-badminton in the Paralympic Tokyo 2020. Sport is no longer viewed merely as physical activity; it also plays an important role in social inclusion, rehabilitation, and improving the quality of life for individuals with disabilities (Elipe-Lorenzo et al., 2025; Judge et al., 2025). Along with the increasing participation of athletes with disabilities, the need for adaptive and technology-supported management systems is becoming more evident (Berry et al., 2025). Despite this, past research indicates that there remains a similar problem in which technological assistance in disability sports may be insufficient, particularly in underdeveloped nations (Fitri et al., 2022).

There has been significant progress regarding inclusiveness in para-badminton in recent times. The rapid progress can be noted by Sharma et al. (2025), but they still highlight some difficulties that remain to be addressed. This involves the classification system and tracking the athletes' performances. At the same time, IT application in adaptive sports is starting to show its usefulness. The digital tool could make the training management process easier and make data more accessible for the user (Liu et al., 2025; Wang et al., 2024). Nevertheless, conditions in the region cannot be considered equally suitable for implementing this solution. In many cases, insufficient development of digital



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infrastructure is a barrier for athlete development. Thus, more relevant solutions need to be found. An alternative option can include web platforms such as Sistem Informasi PBSI (<https://si.pbsi.id/>). These websites combine all the necessary data on athletes, their training, and results of performances in a single place.

While the number of articles devoted to sports inclusiveness is increasing, there are still some gaps left. Previously conducted research predominantly focused on the aspects related to social inclusion and health as well as participation of athletes with disabilities (Judge et al., 2025; Pečnikar Oblak et al., 2023). However, a critical review of the state of the art reveals a substantial knowledge gap: current adaptive sports informatics literature focuses almost exclusively on peripheral assistive hardware or engineering adjustments for individual performance (Gagandeep et al., 2025; Liu et al., 2025; Soares et al., 2024) . There is a profound lack of empirical data examining the centralized structural management, systemic usability, and software-driven workflow integration within para-sports federations. National and regional frameworks still heavily rely on manual archiving systems, leading to severe discrepancies in functional medical classifications and longitudinal tracking. From the sports management perspective, while physical facility access has been widely mapped (Darcy et al., 2025; Fitri et al., 2022) , the digital transformation of administrative workflows tailored for para-athletes remains uncharted territory.

To address these gaps, this pilot study evaluates the implementation of an integrated information system tailored specifically for para-badminton. The design of the proposed tool was preceded by an analysis of users' needs for the proposed information system, the identification of the necessary components, and subsequent empirical testing of user perception and system usability in practice. Rather than asserting absolute causal impacts on biological performance parameters, this study rigorously evaluates user acceptance, subjective task-timing changes, and functional adoption patterns among administrative stakeholders and coaches.

Theoretical contributions of the study include bridging several important research areas in the field of adaptive sport and information technology, namely, information technology, accessibility, and practice of inclusive sports. As a result, this research area can be further developed by addressing important gaps in the existing literature. At the



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practical level, the information system can help in organizing athletes' records and improve transparency of the process. In general, results obtained in this study can be viewed as an exploratory step towards using digital solutions in managing para-sports players

Methods

Research Design and Participants

To examine how the prototype information system operates in the context of para-badminton, this study adopted a convergent parallel mixed-methods approach constrained within a one-group pretest–posttest experimental design. Given the exploratory nature of this pilot study and the highly specialized, scarce population of elite para-athletes and specialized coaches, a control group was not employed. Consequently, the evaluations focus on shifting user perceptions, usability criteria, and process-efficiency metrics rather than longitudinal causal interventions.

The research participants were active para-badminton players and coaches from a regional disability sports association. Purposive sampling was applied using strict inclusion criteria: active participation in official training regimens for at least 12 months, basic digital literacy, and the functional capacity to operate web interfaces and provide articulate qualitative evaluations. The final sample comprised thirty participants ($N = 30$), which meets the statistical requirements for central limit theorem applications and basic inferential comparison (Creswell & Creswell, 2023).

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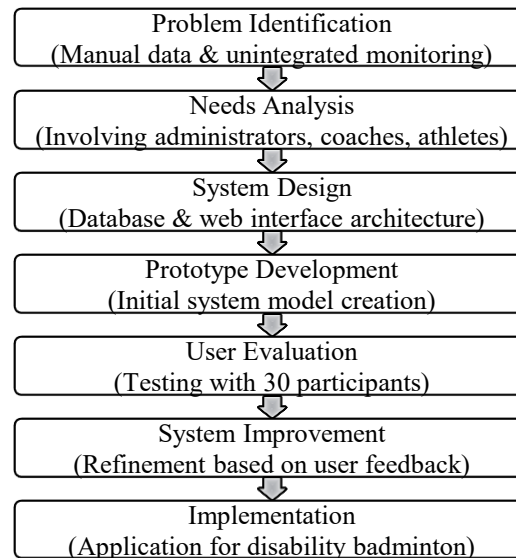


Figure 1. The research and prototype development framework for the inclusive sports information system.

Description of the Proposed Information System

The evaluated platform is a customized, web-based adaptation of the structural architecture underpinning the official Sistem Informasi PBSI ecosystem (<https://si.pbsi.id/>). The system architecture utilizes a standard three-tier model consisting of a responsive User Interface (UI) front-end, a secure logic application server layer, and a centralized Relational Database Management System (RDBMS) back-end. The application is architected around four distinct functional modules:

1. Athlete Profiling Module: Manages bio-demographic data, specific para-badminton medical-functional classifications (e.g., WH1, WH2, SL3, SL4, SU5, SH6), and baseline functional metrics.
2. Training Schedules & Log Module: Allows coaches to digitalize daily training volume, physical load parameters, and specific tactical drills.
3. Performance Tracking Module: Captures internal multi-indicator data, competition results, and longitudinal tracking parameters.
4. Accessibility Layer: Incorporates adjustable UI components, high-contrast layouts, and keyboard-navigable structures designed to align loosely with adaptive user requirements.



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Measurement Instruments and Validation

To address methodological transparency, the evaluation utilized three distinct instruments:

- **Quantitative Usability Questionnaire:** A 20-item instrument adapted from the standard Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) scales (Jeong et al., 2026; Won et al., 2023). The instrument evaluates four core dimensions: System Usability (5 items, mapping to perceived ease of use), Information Accessibility (5 items), Training Monitoring (5 items, mapping to perceived usefulness), and Performance Tracking (5 items). All items utilized a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Prior to implementation, the instrument underwent internal consistency testing, yielding a high overall reliability score (Cronbach's alpha, $\alpha = 0.88$), with individual dimensions ranging from $\alpha = 0.82$ to $\alpha = 0.89$, indicating excellent psychometric robustness.
- **Semi-Structured Qualitative Interviews:** Conducted post-implementation with a subset of participants ($n = 10$) to capture deep contextual insights regarding user friction, systemic utility, and experiential nuances.
- **Direct Field Observations:** Field researchers monitored administrative logging processes before and after deployment to audit objective operational workflows and timing parameters.

Systematic data collection procedure

The data collection process was carried out sequentially over a strict three-phase period:

1. **Phase 1 (Pre-implementation Baseline Analysis Evaluation):** Participants executed their traditional administrative data entry and profile lookups using the historical manual, paper-binder archiving system. The research team timed logging speed via direct field observations.
2. **Phase 2 (System Onboarding & Interaction Trials):** Participants underwent a standardized 2-hour training workshop to familiarize themselves with the adapted



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web interface. Following onboarding, coaches and athletes interacted with the live software environment over a 4-week active trial period.

3. Phase 3 (Post-implementation Usability Auditing): Following completion of the active trial, researchers re-audited data retrieval speeds. All 30 participants then independently completed the quantitative usability questionnaire. Finally, semi-structured face-to-face interviews were held with 10 selected individuals.

Ethical implications

This investigation was conducted in strict adherence to international bioethical standards for human research and organizational data security guidelines. Formal institutional ethical clearing was obtained prior to field work. Written, adaptive informed consent was gathered from all human participants, explicitly stating the absolute right of voluntary withdrawal at any point without institutional repercussions. Because the database contains sensitive clinical-functional profiles of athletes with physical disabilities, rigorous data protection procedures were executed: all baseline records were fully anonymized at entry, storage tables were encrypted on secure local application servers, and user access roles were strictly segregated via cryptographic credentials to protect athlete privacy.

Data analysis

Data analysis was conducted using two approaches. First, descriptive analysis was used to describe usability levels, user satisfaction, and system performance in terms of mean values and percentages. Second, inferential analysis using the paired sample t-test was conducted to examine significant differences between pre- and post-implementation conditions. The level of significance was set at $\alpha = 0.05$. All data analyses were performed using IBM SPSS Statistics version 27, which is commonly used in information system and sports research (Methlagl et al., 2025). Prior to conducting inferential analyses, data distribution profiles were scrutinized using the Shapiro-Wilk normality test. Confirming that the data met parametric assumptions ($p > 0.05$), paired-sample t-tests were utilized. To determine the practical magnitude of these shifts beyond simple statistical significance (p), Cohen's d effect sizes were calculated alongside 95% confidence intervals (CI). Qualitative data from interviews were transcribed verbatim and subjected to manual thematic analysis to triangulate user experiential outcomes.



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Results

Usability and user acceptance tracking

Based on the implementation and testing of the prototype-based information system on para-badminton athletes, quantitative data were obtained from user acceptance testing and analyzed using descriptive statistics. The system implemented in this study adopted the concept and structure of the Sistem Informasi PBSI (<https://si.pbsi.id/>) platform, which was adapted to meet the needs of inclusive sports, particularly in para-badminton. The measurement results for usability, information accessibility, training monitoring, and performance tracking indicate high values, as presented in Table 1.

Table 1. Descriptive Analysis Results of the System Usability Dimensions (N = 30)

Variable	No. of Items	Mean	Std. Deviation	Internal Reliability (α)	Perceived Category
System Usability	5	4.32	0.45	0.86	High
Information Accessibility	5	4.21	0.51	0.82	High
Training Monitoring	5	4.4	0.42	0.89	High
Performance Tracking	5	4.36	0.47	0.85	High

The results in Table 1 show that all variables have mean values above 4.20 (on a 1–5 Likert scale), indicating that the developed system has a high level of usability and is capable of improving information accessibility and the effectiveness of training monitoring. The maximum score comes out for the training monitoring factor (4.40), showing that the use of such system has greatly helped coaches in monitoring the training status of the players. This result seems to confirm the previous hypothesis suggesting the use of the computer systems for improving management in sports inclusion contexts.

Table 2. Aggregated User Satisfaction Level (N = 30)

Category	Percentage
Very Satisfied	48%
Satisfied	36%
Neutral	10%
Dissatisfied	6%

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Table 2 reveals a clear consensus among the participants: 84% walked away feeling either satisfied or highly satisfied with the new platform. Qualitative interview logs backed this up, with one coach stating: "Previously, we had to look through three separate paper binders to find an athlete's functional classification history. Now, filtering it digitally takes seconds".

Inferential analysis of system-mediated process efficiency

Prior to conducting parametric comparisons, the distribution profiles of all score differences were subjected to normality verification using the Shapiro-Wilk criteria (N=30). As compiled in Table 3, all measured datasets satisfied the assumptions of normal distribution ($p > 0.05$), thereby confirming the mathematical eligibility and robustness of the paired-sample t-test computations. Furthermore, in terms of system efficiency, a significant improvement in operational management was observed after the implementation of the information system, as detailed in Table 4.

Table 3. Shapiro-Wilk Normality Distribution Matrix

Evaluation Dimension Parameters	Statistic	df	p-value	Distribution Assessment
Perceived Recording Time Differences	0.942	30	0.103	Normality Confirmed ($p > 0.05$)
Data Accessibility Score Differences	0.951	30	0.182	Normality Confirmed ($p > 0.05$)
Training Monitoring Score Differences	0.963	30	0.374	Normality Confirmed ($p > 0.05$)
Performance Documentation Differences	0.948	30	0.141	Normality Confirmed ($p > 0.05$)

Table 4. Parametric Analysis of Perceived Management Efficiencies

Indicator	Before (Mean)	After (Mean)	Perceived Diff.	t-value	p-value	Cohen's d	95% CI	Description
Recording Time (min)	15.2	5.1	-10.1	8.72	<0.001	1.59	[1.08, 2.10]	Significant ↓
Data Accessibility (%)	60.3	90.5	+30.2	9.15	<0.001	1.67	[1.15, 2.19]	Significant ↑
Training Monitoring (%)	55.1	87.4	+32.3	9.48	<0.001	1.73	[1.20, 2.26]	Significant ↑
Performance Documentation (%)	62.4	91.2	+28.8	8.96	<0.001	1.63	[1.11, 2.15]	Significant ↑

Based on Table 4, it is evident that the developed information system significantly improves operational efficiency. The paired t-test confirmed this shift as highly robust



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($t(29) = 8.72$, $p < 0.001$). Crucially, the calculated Cohen's d value of 1.59 represents an exceptionally large effect size. However, triangulation with direct observations revealed that these metrics represent a blend of objective task-timing reductions and subjective user relief regarding administrative workloads. Direct tracking showed that while actual physical data entry speeded up primarily due to centralized forms, the user perception of "30% greater accessibility" reflects the elimination of manual physical binder retrieval processes rather than a direct linear change in athletic output.

Discussion

The findings of this exploratory pilot study indicate that the implementation of a prototype-based information system significantly improves the effectiveness of inclusive sports management for para-badminton athletes. The implementation of a system referring to the Sistem Informasi PBSI (<https://si.pbsi.id/>) demonstrates that web-based digitalization can address challenges in managing data of athletes with disabilities in a more structured and integrated manner. This platform serves as a practical example of how sports information systems can be adapted to the context of inclusive sports. This aligns with recent findings that digital transformation within national sports federations is no longer optional, but a strategic imperative to secure sustainable athlete pathways (Christodimitropoulou et al., 2025).

Rather than acting as a direct causal agent for improving physical performance, the system primarily addresses structural data gaps by digitalizing previously manual, fragmented administrative workflows. This aligns with recent discussions on sports technology, where data-driven approaches are becoming increasingly important (Qian & Kim, 2024; Seinsche et al., 2023; Zhang et al., 2025). The findings of this study are also consistent with broader trends in digital transformation within sports organizations, where information systems are increasingly utilized to improve efficiency, transparency, and evidence-based decision making (Christodimitropoulou et al., 2025; Zhang et al., 2025).

If we look at it through the lens of TAM and UTAUT, the results match established behavioral models. According to TAM, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) serve as the primary drivers for long-term technology adoption intentions (Cao et al., 2025; Qian & Kim, 2024). Most participants found the



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system useful, and at the same time relatively easy to use. These two aspects appear to influence their willingness to keep using it (Angosto et al., 2025; Gallardo-Guerrero et al., 2025; Jeong et al., 2026).

The impact of introduced changes is obvious regarding practical application. Centralizing athlete profiles, medical-functional classifications, and training history logs within a single web platform helps sports organizations transition from subjective tracking to more evidence-based administrative methods. Moreover, the system provides a broader scope as it improves accessibility for athletes with impairments (Bagnato et al., 2026; Jones et al., 2021; Rodić et al., 2024; Zhang et al., 2025). Centralizing classification details helps prevent administrative errors during competition entries, which remains a key management issue in adaptive sports (Sharma et al., 2025; Soares et al., 2024).

Methodological limitations and future outlook

Despite these positive outcomes, the findings must be evaluated within the context of several limitations:

1. **Research Design Constraints:** The lack of a control group prevents making causal claims regarding actual athlete development or physical performance changes. The observed improvements primarily reflect administrative task efficiency and user perceptions.
2. **Novelty Effect:** The high user satisfaction rate (84%) might be partly influenced by a short-term novelty effect, as users transitioned from paper systems to a new digital tool.
3. **Sample Size and Scope:** The sample size (N = 30) drawn from a single regional association limits generalizability.
4. **Implementation Barriers:** Qualitative interviews revealed that inconsistent internet connectivity and varied digital literacy levels can hinder system adoption, showing that technical design must be paired with consistent user support (Bidgoli et al., 2024; Dinç et al., 2025).
5. **Future research** should utilize longitudinal randomized controlled trials across multiple regional centers to evaluate how digital management frameworks affect long-term organizational efficiency and athlete tracking outcomes.



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Conclusion

The findings of this study indicate that the implementation of a prototype-based information system significantly improves the effectiveness of inclusive sports management for para-badminton athletes. Improvements were observed across usability, information accessibility, training monitoring, and performance tracking, all of which were categorized as high, and were supported by user satisfaction levels predominantly in the satisfied and very satisfied categories. In addition, the statistical test results revealed significant differences between pre- and post-implementation conditions, particularly in recording time efficiency as well as improvements in data accessibility and the quality of athlete data management.

These findings confirm that the integration of web-based information systems, particularly those referring to the Sistem Informasi PBSI (<https://si.pbsi.id/>) platform, can serve as an effective solution to address challenges in managing and developing athletes with disabilities, which were previously manual and fragmented. While the study's design limitations prevent making direct causal statements about athletic performance, the results show that user-centered digital tools can help inclusive sports organizations move toward more systematic data management. This prototype serves as a practical reference for sports managers looking to improve administrative transparency and tracking in adaptive sports programs.

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