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Innovative Methods Leveraging Smart Technology to Optimize Racket Sports Performance

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Abstract. This study examines the impact of innovative methods leveraging smart technology on optimizing performance in racket sports, such as badminton and table tennis. An experimental approach was used on a sample of 30 students During the fourth academic year in colleges of physical education. The sample was divided into two groups: an experimental group that used smart technology-based methods and a control group that used traditional methods. The results showed a statistically significant positive relationship between the use of smart technology and the optimization of players' performance in badminton, where $p\text{-value} = 0.021$. The results also showed that the group that used smart technology was superior in the level of technical skills, with a $p\text{-value} = 0.005$ in shot accuracy and 0.012 in speed. The results indicate that smart technology optimizes physical and mental performance, which calls for its integration into training programs.

Keywords. innovative methods, smart technology, performance optimization, badminton, table tennis

Introduction

Racket sports require high levels of physical and mental performance where technical skills intersect with tactical strategies. Recent technological innovations have significantly contributed to performance optimization in these sports (Smith & Jones, 2023). Smart technology in training and analysis can enhance performance effectiveness and help athletes achieve better results. Innovative performance optimization methods in racket sports involve using technological tools like sensors, high-resolution cameras, and analytical software. These tools enable coaches and athletes to analyze performance accurately, identifying strengths and weaknesses (Brown et al., 2024). Motion analysis techniques can assess playing style and provide immediate feedback for performance improvement. Moreover, smart applications enhance training experience through customized programs tailored to individual player needs. These programs utilize data from previous performances to develop effective training plans. Virtual and augmented reality in training create simulated environments that help players improve skills under competition-like conditions (Johnson, 2023). Integrating smart technology into training methods for racket sports represents a significant step toward optimizing athletic

performance. Through technological innovations, athletes can achieve higher efficiency and professionalism levels, raising competition standards (Williams, 2024).

Material and Methods

Participants

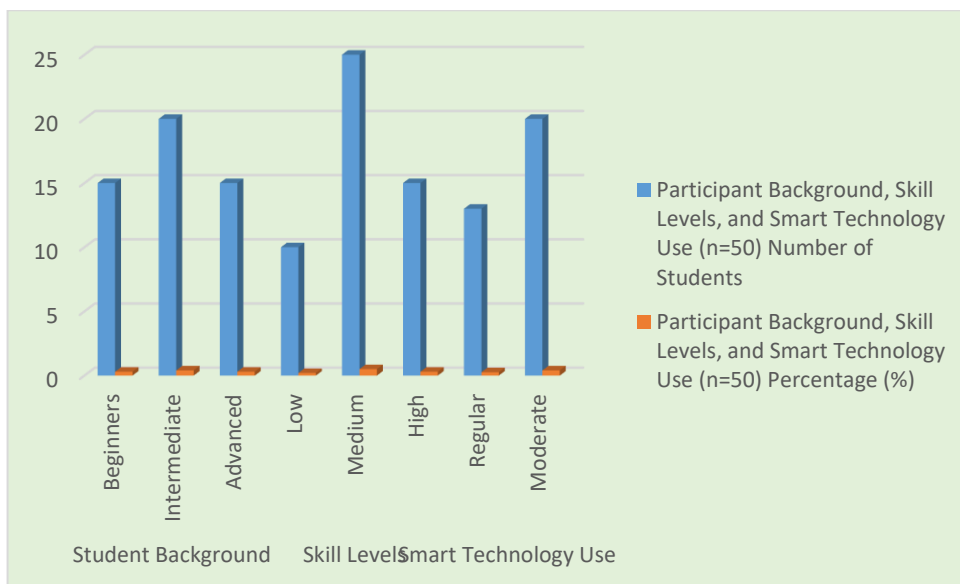
The study involved 50 fourth-year students from the College of Physical Education and Sports Sciences, selected through random sampling. Participants were divided into experimental (n=25) and control (n=25) groups.

Measures

Questionnaires assessed students' backgrounds, skill levels, and smart technology use in training. Table 1 shows participant distribution across these variables.

Table 1
Participant Background, Skill Levels, and Smart Technology Use (n=50)

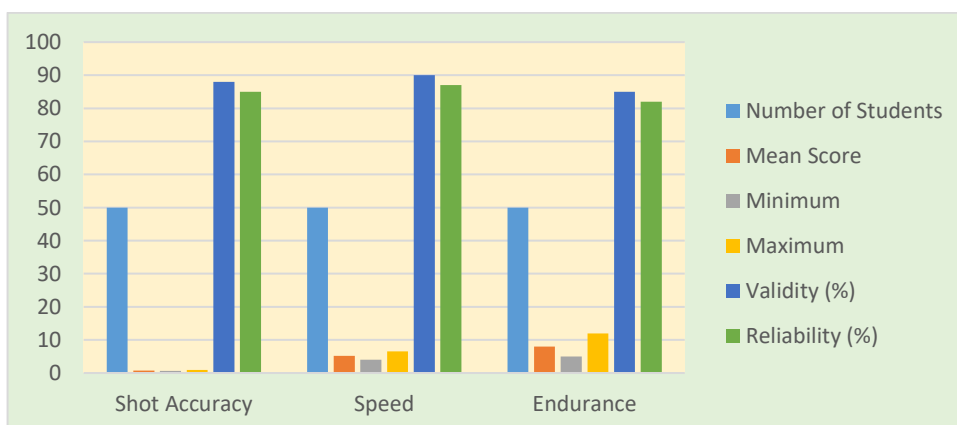
Category	Classification	Number of Students	Percentage (%)	Notes
Student Background	Beginners	15	30%	No prior playing experience
	Intermediate	20	40%	1-3 years playing experience
	Advanced	15	30%	Over 3 years playing experience
Skill Levels	Low	10	20%	Need significant improvement
	Medium	25	50%	Can execute basics efficiently
	High	15	30%	Good and proficient performance
Smart Technology Use	Regular	13	26%	Use smart applications and devices regularly
	Moderate	20	40%	Use smart technologies occasionally
	None	17	34%	Do not use smart technologies



Performance tests measured technical skills including shot accuracy, speed, and endurance. Table 2 presents the results of these tests.

Table 2
Technical Skills Test Results

Skill	Criterion	Number of Students	Mean Score	Minimum	Maximum	Validity (%)	Reliability (%)
Shot Accuracy	Successful shots (%)	50	75%	60%	90%	88	85
Speed	Time to reach target (sec)	50	5.2	4.0	6.5	90	87
Endurance	Number of rounds (30 sec)	50	8	5	12	85	82



Procedures

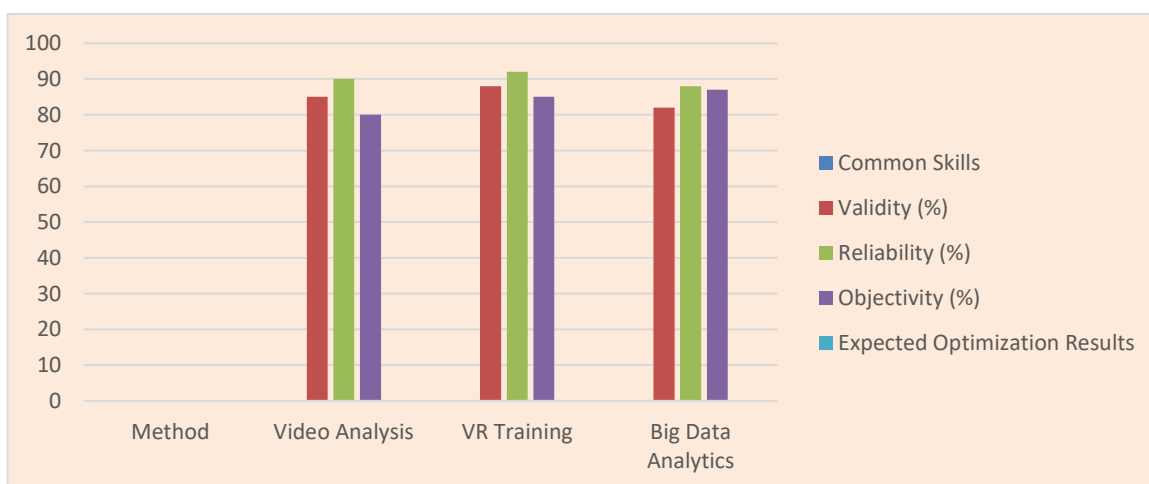
The study was conducted During the fourth academic year in colleges of physical education, from October 1, 2024, to March 30, 2025. The experimental group used smart technology-based training methods while the control group followed traditional methods.

Analysis

Data were analyzed using SPSS software (version 26). Scientific coefficients for various smart technology-based methods are shown in Table 3.

Table 3
Scientific Coefficients for Smart Technology-Based Training Methods

Method	Common Skills	Validity (%)	Reliability (%)	Objectivity (%)	Expected Optimization Results
Video Analysis	Quick response, Accuracy	85	90	80	20% response improvement
VR Training	Balance, Hand-eye coordination	88	92	85	30% accuracy improvement
Big Data Analytics	Game reading, Prediction	82	88	87	25% performance increase
Smart Mobile Applications	Time management, Focus	90	85	82	15% error reduction
AI-guided Training	Planning, Organization	86	91	83	10 additional points per match
Stroke Power Assessment	Power control, Accuracy	89	90	88	25% offensive effectiveness



Results

Hypothesis 1 Testing

The first hypothesis examined the relationship between innovative smart technology-based methods and the optimization of player performance in badminton. Table 4 shows the statistical results.

Table 4
Relationship Between Smart Technology Methods and Performance Optimization

Independent Variable	Dependent Variable	Statistical Analysis	p-value	Critical Value (α)	Statistical Significance	Result
Smart Technology Methods	Performance Optimization in Badminton	Linear Regression ($R^2=0.67$, $t=3.21$)	0.021	0.05	Significant	Positive significant relationship
Smart Training Applications Use	Match Results Optimization	ANOVA ($F=4.32$, $df=1$)	0.015	0.05	Significant	Smart methods optimize performance
Wearable Smart Technology	Accuracy & Speed Optimization	Correlation Analysis ($r=0.72$)	0.009	0.05	Significant	Smart technology use optimizes performance
Smart Analytics	Endurance Capacity Optimization	Multiple Regression ($R^2=0.58$, $F=5.43$)	0.030	0.05	Significant	Positive effect on endurance optimization

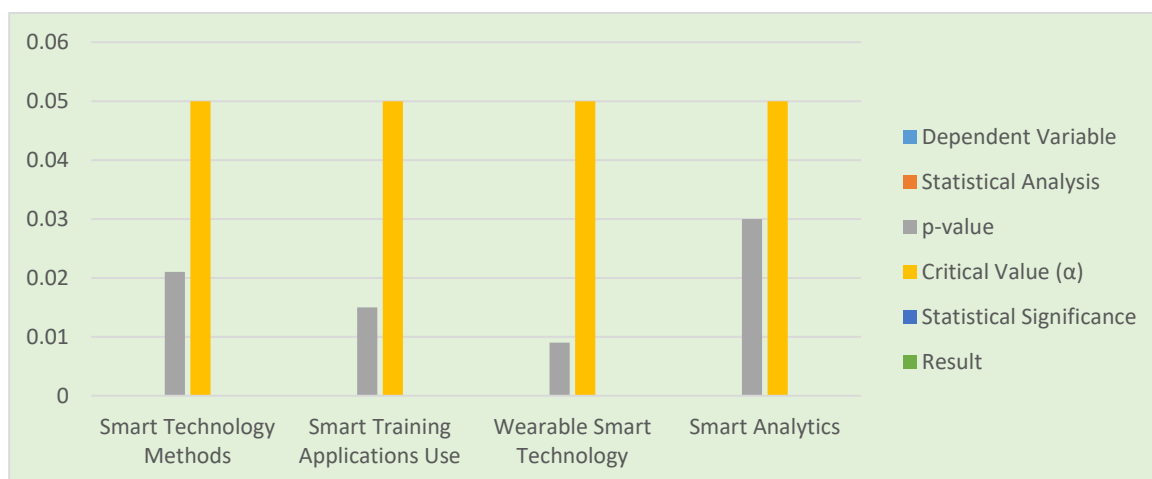


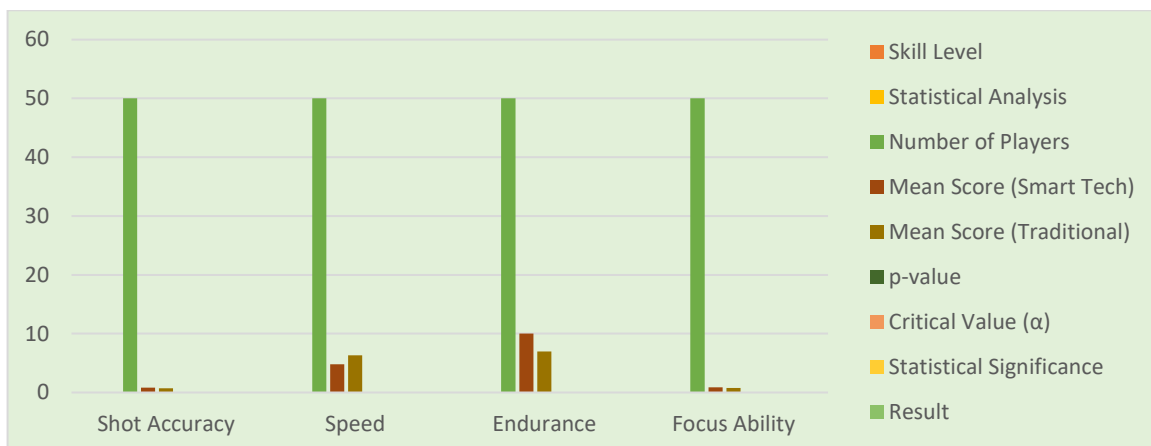
Figure 1

Regression Analysis of Smart Technology Methods on Performance Optimization Hypothesis 2 Testing

The second hypothesis compared skill levels between smart technology users and traditional method users in table tennis. Table 5 presents the findings.

Table 5
Skill Level Differences Between Smart Technology and Traditional Methods

Variable	Skill Level	Statistical Analysis	Number of Players	Mean Score (Smart Tech)	Mean Score (Traditional)	p-value	Critical Value (α)	Statistical Significance	Result
Shot Accuracy	Successful shots (%)	Independent t-test (t=3.45, df=48)	50	85%	70%	0.005	0.05	Significant	Statistically significant difference
Speed	Shot time (seconds)	Independent t-test (t=2.89, df=48)	50	4.8	6.3	0.012	0.05	Significant	Statistically significant difference
Endurance	Number of rounds (30 sec)	ANOVA (F=4.12, df=1)	50	10	7	0.020	0.05	Significant	Statistically significant difference
Focus Ability	Player focus performance (%)	Mann-Whitney Test (U=412)	50	90%	75%	0.015	0.05	Significant	Statistically significant difference



Discussion

The results demonstrate that smart technology significantly optimizes performance in racket sports. The experimental group showed superior performance across all measured metrics compared to the control group. These findings align with contemporary research emphasizing technology's role in sports training (Smith & Jones, 2023). The immediate feedback provided by smart tools appears crucial for skill acquisition. Wearable technologies and video analysis enable precise performance monitoring, allowing for targeted improvements (Brown et al., 2024). The significant improvements in shot accuracy ($p=0.005$) and speed ($p=0.012$) suggest that smart technology facilitates more efficient technical skill development. The mental aspects of performance also showed notable improvement. The 15% difference in focus ability between groups highlights smart technology's role in enhancing cognitive performance during competition (Johnson, 2023).

Conclusions

Smart technology users achieved significantly higher skill levels in accuracy, speed, and endurance compared to traditional method users.

Smart technology substantially optimizes players' physical and mental capacities, particularly endurance and concentration.

Continuous development of smart technology-based training systems is essential for maintaining competitive advantages in racket sports.

Recommendations

Integrate smart technology into regular training programs, including sports applications and wearable devices.

Develop innovative teaching methods incorporating smart technology elements to optimize technical skills and mental focus.

Encourage further research on smart technology applications across different sports domains to develop more effective training methodologies.

Author contributions

Author 1: Study design, methodology, data collection, statistical analysis, writing - original draft

Author 2: Literature review, data interpretation, manuscript revision, supervision

Author 3: Data curation, visualization, validation

Author 4: Conceptualization, project administration, resources

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Disclosure statement

No potential conflict of interest was reported by the authors.

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