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Analysis of Factors Influencing Success in Badminton through the Integration of Performance, Social, and Survey Data Using Artificial Intelligence Methods

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ABSTRACT

The objective of this study is to analyze the factors influencing success in the sport of badminton by integrating performance, social, and survey data and to identify the key drivers of the development of this sport using artificial intelligence methods. This applied study was conducted using a qualitative approach and a descriptive phenomenological method. The study population consisted of university faculty members, coaches, professional and semi-professional badminton athletes, and sports analysts, from whom 26 participants were ultimately selected as the sample. Data were collected through semi-structured interviews and subsequently analyzed and coded. The validity and reliability of the data were ensured based on the criteria of credibility, transferability, dependability, and confirmability. The results indicated that success in badminton is influenced by a combination of factors, including individual and technical performance, athletic motivation and commitment, social and team interactions, the utilization of technology and data analytics, environmental conditions and training facilities, as well as competitive decision-making and strategic planning. The application of performance data and artificial intelligence technologies enables continuous performance monitoring, technical improvement, intelligent planning, and the identification of the principal drivers of success. This study demonstrates that the integration of performance, social, and survey data using artificial intelligence methods provides a deeper understanding of the factors influencing success in badminton and facilitates the design of optimal training programs to enhance athletes' performance. The findings offer significant practical implications for improving training quality, identifying talent, and predicting performance, and can serve as an effective guide for coaches and sports organizations.

Keywords: Badminton, performance data, social and survey data, artificial intelligence

Introduction

Badminton has evolved from a recreational activity into a highly competitive global sport characterized by rapid tactical exchanges, complex technical demands, and increasing professionalization of training systems. Contemporary performance in badminton is no longer determined solely by physical fitness or technical execution; rather, it emerges from the dynamic

interaction of physiological, psychological, social, tactical, environmental, and technological factors. This multidimensional nature of performance has stimulated extensive scholarly attention aimed at identifying the determinants of success and designing evidence-based development systems for athletes at different competitive levels (Baker, Schorer, et al., 2018; Baker, Wattie, et al., 2018; Collins et al., 2019). As international competition intensifies and margins between elite athletes narrow, the need for precise, data-driven models of performance optimization and talent development has become a central priority within sports science and management research.

The modern management of badminton performance requires an integrative framework that simultaneously accounts for long-term athlete development, individualized training prescription, psychological preparation, and technological support systems. Traditional training paradigms, which focused predominantly on physical conditioning and repetitive skill acquisition, have gradually given way to more holistic models emphasizing adaptive learning, cognitive engagement, and contextualized practice environments (Bompa & Buzzichelli, 2015; Collins et al., 2015). In this transition, performance analysis has assumed a pivotal role by enabling systematic monitoring of technical execution, tactical decision-making, and physiological responses during training and competition. Such analytical approaches have allowed coaches and sport organizations to optimize workload distribution, refine training periodization, and reduce injury risk while enhancing competitive readiness (Bompa & Buzzichelli, 2015).

Within this broader transformation, badminton has emerged as a particularly fertile domain for performance research due to its high perceptual-cognitive load, rapid tempo, and extreme physical demands. Success in badminton requires precise stroke mechanics, anticipatory skills, agility, muscular power, and sustained psychological resilience under pressure (Charee et al., 2022; Shedge, 2024). Empirical studies have demonstrated that targeted conditioning interventions, such as plyometric and step-aerobic training, significantly enhance agility, power, and movement efficiency among badminton athletes, underscoring the critical importance of scientifically grounded training programs (Charee et al., 2022; Shedge, 2024). Moreover, visual perception, reaction time, and sensorimotor integration have been identified as core performance components, particularly among junior and elite female athletes (Ikarugi et al., 2005). These findings reinforce the necessity of multidimensional performance models that move beyond isolated physical metrics.

Psychological and social variables constitute another essential dimension of badminton success. Athletes' motivation, self-confidence, emotional regulation, and mental fitness directly influence training adherence, competitive composure, and performance stability under high-pressure conditions (Eskandarnejhad et al., 2021; Moghadam et al., 2013). Mindfulness-based interventions have been shown to reduce anxiety and improve performance consistency among badminton players, demonstrating the interdependence between psychological well-being and athletic achievement (Moghadam et al., 2013). Furthermore, social support structures, including coach-athlete relationships, team cohesion, and peer networks, play a crucial role in sustaining motivation and facilitating long-term athlete development (Pouriya et al., 2025). In educational contexts, sport-based instructional models such as Sport Education and non-linear pedagogy have been found to strengthen self-esteem, sport confidence, and intrinsic motivation among university badminton students (Nathan, 2016; Nathan et al., 2018; So et al., 2020).

Parallel to these psychosocial factors, the strategic and tactical dimensions of badminton performance have become increasingly sophisticated. Game success now depends on players' capacity to analyze opponents, adapt to evolving match conditions, and implement flexible tactical solutions in real time. Contemporary research emphasizes the importance of

experiential learning, competition exposure, and reflective practice in cultivating elite performance trajectories (Cobley & Till, 2017; Collins et al., 2015). Longitudinal tracking of athlete development has been recommended as a core management strategy to support evidence-based decisions regarding training progression, competition scheduling, and talent transitions across developmental stages (Cobley & Till, 2017).

Talent identification and development (TID) systems represent another critical pillar of badminton success management. Despite significant advances, TID remains methodologically challenging due to the nonlinear, context-dependent nature of athletic development (Baker, Schorer, et al., 2018; Baker, Wattie, et al., 2018; Bergkamp et al., 2019). In badminton specifically, comparative studies between China and the United Kingdom reveal substantial variation in selection criteria, development pathways, and institutional support mechanisms, highlighting the influence of national sport ecosystems on performance outcomes (Yuon Gao & Robinson, 2017). In developing countries, limitations in infrastructure, coaching education, and resource allocation further complicate systematic talent development processes (Bayazit, 2021). Consequently, scholars increasingly advocate for dynamic, data-informed TID frameworks that integrate technical, physical, psychological, and social indicators rather than relying on early specialization or isolated performance metrics (Bergkamp et al., 2022; Collins et al., 2019; Siyahi & Asghari Pour Dasht Bozorg, 2020).

The rapid expansion of digital technologies and artificial intelligence has fundamentally reshaped performance analysis and sport management practices. Advanced motion-tracking systems, machine learning algorithms, and large-scale performance datasets now enable precise modeling of technical execution and tactical behavior in badminton (Wang et al., 2023; Wang, 2024; Wu, 2023). The development of annotated stroke-level datasets such as ShuttleSet has provided unprecedented opportunities for automated tactical analysis, facilitating opponent modeling, performance prediction, and decision-support systems for coaches and athletes (Wang et al., 2023). Machine learning-based movement recognition systems further enhance training personalization by offering real-time feedback on stroke quality and movement efficiency (Wang, 2024; Wu, 2023). These technological advances have effectively shifted badminton performance management from intuition-based decision-making toward predictive, evidence-driven optimization frameworks.

The integration of artificial intelligence within performance management also supports comprehensive athlete monitoring, encompassing physiological readiness, workload distribution, injury risk assessment, and psychological status (Ihsan et al., 2024; Khan et al., 2024). Learning frameworks that combine leadership attributes, mental resilience, and fitness indicators have demonstrated strong predictive capacity for badminton performance outcomes, confirming the value of multi-source data fusion (Khan et al., 2024). Systematic reviews further emphasize the necessity of individualized physical conditioning programs aligned with the specific physiological and biomechanical demands of badminton competition (Ihsan et al., 2024). Such findings reinforce the central role of data-integrated performance ecosystems in contemporary sport management.

Social dynamics in the digital era have introduced new variables into athlete development and performance sustainability. Online social media platforms influence athletes' motivation, public identity, sponsorship opportunities, and psychological well-being, particularly among professional badminton players (Shan, 2023). While social media can strengthen engagement and visibility, it also introduces novel performance pressures that require careful management by sport organizations and coaching staff. At the grassroots level, initiatives aimed at promoting badminton participation among youth and school

populations underscore the importance of early exposure, enjoyment, and inclusive development pathways for sustaining the sport's long-term growth (Mulyana, 2024).

Despite the expanding body of research on individual performance components, psychological skills, talent development, and technological innovation, existing literature remains fragmented. Most studies examine isolated factors rather than exploring their interactive effects within an integrated performance system. This fragmentation limits the ability of sport managers and policy makers to construct coherent development strategies that align training design, talent identification, technological investment, and organizational planning. Scholars increasingly emphasize the necessity of holistic performance frameworks that synthesize performance data, social dynamics, and athlete perceptions into unified decision-making models (Bergkamp et al., 2019; Collins et al., 2019; Pouriya et al., 2025). Such integrative approaches are essential for navigating the growing complexity of high-performance badminton environments.

Moreover, from a sport management perspective, the strategic allocation of resources, design of training infrastructures, and governance of athlete development systems depend fundamentally on accurate understanding of performance determinants. Effective management requires evidence-based evaluation of training interventions, talent pipelines, technological investments, and psychosocial support mechanisms. The convergence of artificial intelligence, performance analytics, and qualitative insights from athletes and coaches presents a unique opportunity to construct comprehensive performance management models capable of enhancing both individual achievement and organizational effectiveness. Therefore, the aim of this study is to analyze the factors influencing success in badminton through the integration of performance, social, and survey data using artificial intelligence methods.

Methodology

The present study is an applied research investigation conducted using a qualitative approach and a descriptive phenomenological method. The primary objective was to identify and analyze the key drivers influencing success and development in badminton through the integration of performance, social, and survey data using artificial intelligence methods.

The participants included faculty members in sport management, badminton coaches and analysts, professional and semi-professional athletes, and experts in racket sports, from whom a total of 26 individuals were ultimately selected as the study sample. Sampling was conducted using purposive and snowball techniques and continued until the emergence of non-redundant concepts was achieved.

Data collection was carried out through semi-structured interviews, which encompassed players' performance information, social data from clubs and coaches, and the results of questionnaires completed by athletes and subject-matter experts. Data analysis was performed using the relevant qualitative analysis software and the Colaizzi method.

To ensure research rigor, the criteria of credibility, transferability, dependability, and confirmability were applied. Two independent coders analyzed the interview data, and the inter-coder agreement coefficient was calculated at 82%, exceeding the accepted standard threshold of 60%.

This research design enabled a comprehensive analysis of the factors influencing success in badminton and the identification of key drivers for the development of this sport through the integration of multi-source data and artificial intelligence methodologies.

Findings and Results

By analyzing the data collected from the participants, the qualitative analysis of the factors influencing success in badminton through the integration of performance, social, and survey data led to the extraction of key concepts such as individual and technical performance, athletic motivation and commitment, social and team interactions, the use of technology and data analytics, the training environment and facilities, and competitive decision-making and strategies. These concepts were categorized into six main themes with several subthemes. The main themes included: individual and technical performance; athletic motivation and commitment; social and team interactions; use of technology and data analysis; training environment and facilities; and competitive decision-making and strategies.

Table 1. Initial Codes

Initial Codes	Participant Code
Individual motivation, regular training, personal planning	P1, P5, P12
Importance of goal setting, use of performance analysis, monitoring progress	P2, P8, P16
Competition experience, stress management, mental focus	P3, P7, P11, P20
Coach's role, team support, individual and group training programs	P4, P9, P13
Impact of nutrition and physiology, strength training, rest management	P5, P14, P21
Performance data analysis, use of technology, physical readiness monitoring	P6, P10, P15
Social interaction with other players, group training, healthy competition	P7, P17, P22
Use of social media for motivation and interaction, observing techniques	P8, P18, P23
Impact of environmental conditions (court, equipment), training time management	P9, P19, P24
Adherence to training programs, following coach's recommendations, monitoring personal progress	P10, P20, P25
Analysis of previous matches, identification of strengths and weaknesses, intelligent planning	P11, P21, P26
Importance of sport psychology, mental training, focus on motivation and self-confidence	P12, P22
Use of statistical data, opponent analysis, game strategy	P13, P23
International competition experience, learning from professional players, adaptation to competition conditions	P14, P24
Use of analytical software and tools, monitoring individual progress	P15, P25
Focus on innovation in techniques and tactics, continuous improvement, self-assessment	P16, P26
Motivational and training campaigns, encouragement to adhere to programs	P17, P21
Analysis of training and competition results, interaction with coaches and analysts	P18, P22
Risk management in games, use of feedback, review of team weaknesses	P19, P23
Evaluation of individual and team performance, planning for continuous improvement	P20, P24
Observing other players' techniques, improving skills through modeling	P21, P23
Analysis of match data, identification of opportunities and threats	P22, P24
Attention to motivation and commitment, encouragement and team support	P23, P25
Goal-oriented training, use of feedback, adherence to AI-based programs	P24, P26
Leveraging technology and data, analyzing player performance, identifying key success drivers	P25, P26
Personal training experience, interaction with coaches, use of performance data	P1, P5, P9
Long-term planning, statistical analysis, data-driven decision-making	P2, P6, P10
Mental training, game strategy, self and opponent performance analysis	P3, P7, P11
Adaptation to technology, use of training software, progress analysis	P4, P8, P12

Table 1 presents the list of initial codes along with the participants' identifiers and illustrates the coding process and the extraction of subthemes. In addition, Table 2 presents the main themes and subthemes of the study to clarify the different levels of qualitative analysis and the semantic structure derived from the data.

Table 2. Extracted Main Themes and Subthemes

Subthemes	Main Theme
Regular training and personal planning; stress management and mental focus; analysis of strengths and weaknesses; use of performance data to improve technique; use of analytical software and tools	Individual and Technical Performance
Personal goal setting; intrinsic and extrinsic motivation; persistence in the face of failure; adherence to training programs and coach's recommendations; self-assessment and continuous progress monitoring	Athletic Motivation and Commitment
Participation in group training; support and cooperation with teammates; interaction with coaches and analysts; membership in clubs and groups; receiving feedback and social support	Social and Team Interactions
Performance data analysis; identification of success drivers using artificial intelligence; physical readiness monitoring; use of sports software and applications; performance prediction and intelligent planning	Use of Technology and Data Analysis
Quality of courts and equipment; access to training resources; training time management; adaptation to competition conditions; environmental impact on performance	Training Environment and Facilities
Design of game tactics; opponent analysis; adaptation to rules and competition changes; selection of individual and team strategies based on data; evidence- and experience-based decision-making	Competitive Decision-Making and Strategies

Table 2 summarizes the qualitative structure of the study by organizing the extracted subthemes into six coherent main themes that collectively explain success in badminton. The theme of Individual and Technical Performance encompasses regular and structured training, personalized planning, stress management and mental focus, systematic analysis of strengths and weaknesses, and the use of performance data and analytical tools to refine technical skills. Athletic Motivation and Commitment reflects the role of personal goal setting, intrinsic and extrinsic motivation, persistence when facing failure, adherence to training programs and coaching guidance, and continuous self-assessment and progress monitoring. Social and Team Interactions highlights participation in group training, collaboration and support among teammates, effective interaction with coaches and analysts, involvement in clubs and organized groups, and the receipt of feedback and social support. The theme of Use of Technology and Data Analysis captures the systematic analysis of performance data, identification of key success drivers through artificial intelligence, monitoring of physical readiness, utilization of sports software and digital tools, and intelligent performance prediction and planning. Training Environment and Facilities includes the quality and availability of courts and equipment, access to training resources, efficient management of training time, adaptation to competition conditions, and the overall influence of environmental factors on performance. Finally, Competitive Decision-Making and Strategies consists of tactical design of play, opponent analysis, adaptation to evolving rules and competitive contexts, selection of individual and team strategies based on empirical data, and decision-making grounded in both evidence and competitive experience.

Discussion and Conclusion

The findings of the present study provide a comprehensive and integrative understanding of the factors that determine success in badminton by synthesizing performance data, social variables, and athletes' experiential perceptions through artificial intelligence–supported analysis. The results demonstrated that success in badminton emerges from the dynamic interaction of six interrelated domains: individual and technical performance, athletic motivation and commitment, social and team interactions, use of technology and data analysis, training environment and facilities, and competitive decision-making and strategies. This multidimensional structure aligns closely with contemporary theoretical perspectives in sport science and management, which emphasize that elite performance is not the product of isolated physical attributes but rather the outcome of complex, interacting systems of biological, psychological, social, and technological influences (Baker, Wattie, et al., 2018; Collins et al., 2019).

The prominence of individual and technical performance as a foundational determinant of success supports previous evidence highlighting the centrality of movement efficiency, stroke mechanics, agility, and physical conditioning in badminton performance. The participants' emphasis on regular training, systematic analysis of strengths and weaknesses, and use of performance data for technical refinement corresponds with empirical findings demonstrating the effectiveness of targeted physical conditioning programs in enhancing agility, power, and technical execution among badminton athletes (Charee et al., 2022; Shedge, 2024). Furthermore, the integration of visual-perceptual training and sensorimotor optimization observed in this study reflects the established link between visual function and competitive performance in junior and elite badminton players (Ikarugi et al., 2005). These results reaffirm that technical mastery and physiological preparedness remain indispensable pillars of success, yet their optimization increasingly depends on data-informed feedback systems.

Athletic motivation and commitment emerged as another dominant theme, reinforcing the view that psychological resilience and sustained engagement critically influence performance stability and long-term development. Participants consistently described goal setting, intrinsic motivation, adherence to training plans, and self-monitoring as essential for maintaining competitive readiness. These observations are strongly supported by research demonstrating that psychological interventions, including mindfulness training, significantly reduce anxiety and enhance performance consistency in badminton athletes (Eskandarnejhad et al., 2021; Moghadam et al., 2013). Moreover, pedagogical models emphasizing learner autonomy and engagement, such as non-linear pedagogy and Sport Education, have been shown to improve sport confidence and intrinsic motivation among badminton students (Nathan, 2016; Nathan et al., 2018; So et al., 2020). The present findings extend this body of knowledge by illustrating how psychological and motivational factors operate in continuous interaction with technical training and competitive strategy, thereby shaping overall performance trajectories.

Social and team interactions constituted a third critical dimension of success, highlighting the role of interpersonal dynamics and organizational support systems in high-performance environments. Participants emphasized the influence of coach-athlete relationships, team cohesion, and peer feedback on learning efficiency and emotional stability. These findings are consistent with contemporary talent development frameworks that recognize social environments as essential components of athlete progression (Cobley & Till, 2017; Collins et al., 2015). Furthermore, recent research on social cohesion in badminton development confirms that collaborative training climates and social support structures significantly enhance athletes' commitment and long-term engagement (Pouriya et al., 2025). The present study contributes to this literature by demonstrating that social processes are not merely supportive but function as active performance determinants that influence motivation, tactical learning, and competitive behavior.

One of the most significant contributions of this study lies in its examination of technology and data analytics as core performance drivers. Participants consistently reported that performance monitoring, data-driven feedback, and artificial intelligence–based planning enhanced technical refinement, physical readiness, and strategic decision-making. These findings align with emerging research demonstrating the transformative impact of machine learning and artificial intelligence on badminton performance analysis. Advanced datasets and motion recognition systems enable automated evaluation of stroke mechanics and tactical behavior, thereby facilitating real-time performance optimization (Wang et al., 2023; Wang, 2024; Wu, 2023). Additionally, predictive learning frameworks integrating leadership attributes, mental resilience, and fitness indicators have shown strong predictive power for performance outcomes in badminton athletes (Khan et al., 2024). Systematic reviews further confirm the necessity of individualized, data-informed conditioning programs to meet the sport's complex physiological demands (Ihsan et al., 2024). The present findings reinforce the strategic value of artificial intelligence as an enabling infrastructure for modern sport management.

Environmental conditions and training facilities were also identified as decisive influences on success. Participants emphasized the quality of courts, equipment, and access to resources, as well as effective time management and adaptation to competition settings. These results echo prior research indicating that infrastructural quality and training context significantly affect skill acquisition and performance consistency, particularly in developing sport systems (Bayazit, 2021). Moreover, educational initiatives aimed at increasing badminton participation in schools demonstrate that early access to appropriate facilities and supportive learning environments plays a crucial role in fostering sustained engagement and future

elite development (Mulyana, 2024). From a sport management perspective, these findings highlight the importance of strategic investment in training environments as a prerequisite for performance excellence.

Competitive decision-making and strategic adaptability formed the final core dimension of success. Participants underscored the importance of tactical planning, opponent analysis, evidence-based strategy selection, and adaptive responses to evolving competition dynamics. These insights correspond with longitudinal research emphasizing experiential learning and reflective practice as key determinants of elite athletic progression (Cobley & Till, 2017; Collins et al., 2015). Furthermore, contemporary talent identification and development literature stresses the necessity of flexible, data-informed decision-making frameworks that accommodate the nonlinear nature of athlete development (Baker, Wattie, et al., 2018; Bergkamp et al., 2022; Bergkamp et al., 2019; Siyahi & Asghari Pour Dasht Bozorg, 2020). The present study extends these perspectives by demonstrating how artificial intelligence–supported analytics strengthen strategic planning and competitive adaptability in badminton.

Collectively, the results of this study substantiate a systems-based understanding of badminton success in which technical, psychological, social, environmental, and technological components function as an integrated performance ecosystem. This holistic perspective mirrors contemporary critiques of reductionist performance models and supports calls for multidimensional talent development frameworks (Baker, Schorer, et al., 2018; Collins et al., 2019). Moreover, the integration of social media influences observed among participants resonates with recent findings on the impact of digital environments on professional badminton players' motivation and public identity (Shan, 2023). The convergence of these factors underscores the increasing complexity of modern badminton performance management and the necessity of comprehensive, data-driven strategic planning.

This study is subject to several limitations that should be acknowledged. First, the qualitative design and purposive sampling approach, while appropriate for exploring complex experiential phenomena, limit the generalizability of the findings to broader badminton populations. Second, the reliance on self-reported data may introduce recall bias and subjective interpretation. Third, although artificial intelligence methods were used for analytical integration, the study did not include longitudinal performance tracking, which would provide deeper insight into causal relationships and developmental trajectories.

Future research should employ longitudinal mixed-method designs to examine how the identified performance dimensions interact over time and across developmental stages. Expanding sample diversity across countries, competitive levels, and age groups would enhance generalizability. Incorporating biometric, physiological, and real-time competition data alongside psychological and social measures could further refine predictive performance models. Comparative studies between traditional coaching approaches and AI-supported training systems are also recommended.

From a practical standpoint, sport organizations and coaches should adopt integrated performance management systems that combine technical training, psychological support, social development, and advanced data analytics. Investment in artificial intelligence infrastructure and coach education in data-driven decision-making is essential. Training environments should be optimized through strategic facility development, structured talent pathways, and supportive social climates that promote athlete well-being, motivation, and sustainable performance growth.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Written consent was obtained from all participants in the study.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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