

Research on Sustainable Development Factors and Countermeasures of “Campus Tennis” Project in Henan Province

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Abstract

This article aimed to (1) study the current conditions and challenges of campus tennis programs in Henan Province; (2) study the key factors affecting the sustainable development of these programs using empirical data and SEM analysis; and (3) propose practical strategies and policy recommendations for enhancing program sustainability. The sample consisted of 231 participants, including 40 tennis coaches, 150 campus tennis professional school tennis team athletes, and 41 parents of students in Henan Province. Purposive sampling was used to select 231 participants for the study, including 40 tennis coaches, 150 student-athletes, and 41 parents. A Delphi-based structured questionnaire was used to gather data, and content analysis, SEM, and descriptive statistics were used for analysis. The findings revealed three key outcomes:

1. Overall, Henan's campus tennis programs were in a moderate state. Only 45% of universities had regular tennis courts, and more than half lacked certified tennis coaches. While there was institutional support, it was frequently not tailored to tennis. Despite a high level of student interest in tennis (62%), only 24% of them regularly participated.

2. SEM results confirmed five key factors influencing program sustainability: institutional support ($\beta = 0.61$, $p < .001$), coaching quality ($\beta = 0.48$, $p < .001$), student participation ($\beta = 0.42$, $p < .01$), infrastructure ($\beta = 0.34$, $p < .05$), and community involvement ($\beta = 0.26$, $p < .05$).

3. Practical strategies were proposed, including developing formal tennis policies, investing in facilities, training coaches, organizing engagement programs, building community partnerships, and aligning with provincial-level policy.

These results add to a sustainability model tailored to tennis and provide useful information for legislators, academic administrators, and sports instructors looking to promote campus athletics in underserved areas.

Keywords: Campus tennis; Henan Province; Higher education; SEM analysis; Sustainable development

Introduction

Campus sports, particularly tennis, have been given priority by China's Ministry of Education and provincial education authorities in recent years in an effort to promote student wellness and national health goals (National Sports Authority China, 2023). However, current research shows that regional differences in campus sports development are still present. For instance, research on sustainable sports development employing DEA and PSR models reveals that although competitive sports in China have advanced overall, central regions still lag behind their eastern counterparts (Zhang et al. 2022). In particular, Henan Province faces challenges that are not taken into consideration in the larger body of literature on campus sports, such as poor infrastructure, disjointed administration, and low student participation in campus tennis (Luo & Wang, 2025). There is a significant knowledge and practice gap in tennis programs in under-resourced Chinese provinces, despite foundational theories emphasizing the value of unified policy and resource sharing for sports sustainability.

In Henan Province, where universities frequently deal with inadequate funding, non-standardized coaching, and a lack of curriculum integration, this study looks at campus tennis programs. Having coordinated university sports in Henan for more than five years, the lead researcher has firsthand knowledge of these operational flaws. Few previous studies have concentrated exclusively on tennis, despite research on campus football and general sports motivation in Chinese students (e.g., Sports motivation in Chinese college students, 2023) offering insights into program engagement and institutional support. Notably, studies on experimental fast-tennis instruction at Henan universities point to enduring gaps in comprehensive program integration while also pointing to possible advantages (An et al., 2022). The results of this study will help stakeholders, including university sports administrators, physical education instructors, and

provincial sports policymakers, create workable, regionally appropriate frameworks for improving campus tennis sustainability.

The purpose of this study is to demonstrate that campus tennis programs in Henan can be carried out in a sustainable manner. In the 2024–2025 academic year, it will employ a mixed-methods approach to identify important organizational, educational, and infrastructure factors that impact sustainability across 30 universities; assess the current state of the program through surveys and in-depth interviews; and suggest specific tactics to enhance management, widespread participation, and resource allocation. Included in this article are: (a) a review of campus sports sustainability frameworks; (b) a methodology detailing data collection and analysis; (c) quantitative and qualitative findings; (d) a theoretical discussion connecting findings to sustainability models; and (e) practical suggestions for decision-makers at the university and provincial levels. In order to improve campus athletics, student health, and institutional resource stewardship in developing nations, this work develops a new, tennis-specific sustainability framework that informs both academic discourse in sports science and real-world policy.

Research Objectives

1. To assess the current conditions and challenges of campus tennis programs in Henan Province.
2. To identify key factors affecting the sustainable development of campus tennis using empirical data and SEM analysis.
3. To propose practical strategies and policy recommendations for enhancing program sustainability.

Literature Review

In order to determine the knowledge gap regarding the sustainable development of campus tennis in Chinese universities, specifically in Henan Province, the authors conducted a review of current and pertinent literature. The review highlights that although a number of sports development programs have been examined in higher education settings, there is still a dearth of research that focuses exclusively on tennis. Highlighting the topics that have been studied and those that are still unexplored, the following themes provide an overview of the current body of research and theoretical frameworks.

1. Campus sports programs that prioritize sustainability

In their analysis of campus football development in China, Liu et al. (2023) used a SWOT framework, which identified institutional strengths as well as shortcomings in long-term planning, funding, and community involvement. Although the results are instructive, tennis programs, which have different infrastructure and participation patterns, cannot directly use them (Deng et al., 2023).

2. Regional Inequalities and Facility Restrictions

Zhang et al. (2022) focused on regional differences, particularly between central and eastern provinces, while analyzing sustainable development in Chinese competitive sports using a DEA-PSR model. The central Chinese province of Henan was cited as having inadequate resources and a lack of strategic coherence. However, neither tennis nor university-level programs are specifically addressed in their work.

3. The Development of Tennis in Educational Environments

Despite student interest, research on tennis development in underdeveloped Chinese regions like Ganzhou reveals obstacles like low institutional support, a lack of curriculum integration, and low awareness (Luo & Wang, 2025). This study highlights the need for more research on regionally focused tennis programs in higher education.

The literature shows how to evaluate sustainability in campus sports using the SWOT and DEA-PSR theoretical frameworks. Nevertheless, campus tennis development has not yet incorporated these models. These frameworks are adopted and modified in this study to fit the tennis context in the universities of Henan Province. By doing this, it seeks to close a significant knowledge gap and offer practical suggestions to administrators of sports programs and educational policymakers.

Conceptual Framework

The purpose of this study is to investigate how campus tennis programs in Henan Province can grow sustainably. The researcher uses the PSR (Pressure-State-Response) model, the SWOT analytical framework, and the Theory of Sustainable Development to define the conceptual framework (Lahouel et al., 2023). Together, these models offer a thorough foundation for determining the determinants of success, evaluating the efficacy of programs, and formulating suitable plans for long-term expansion. Here are the specifics:

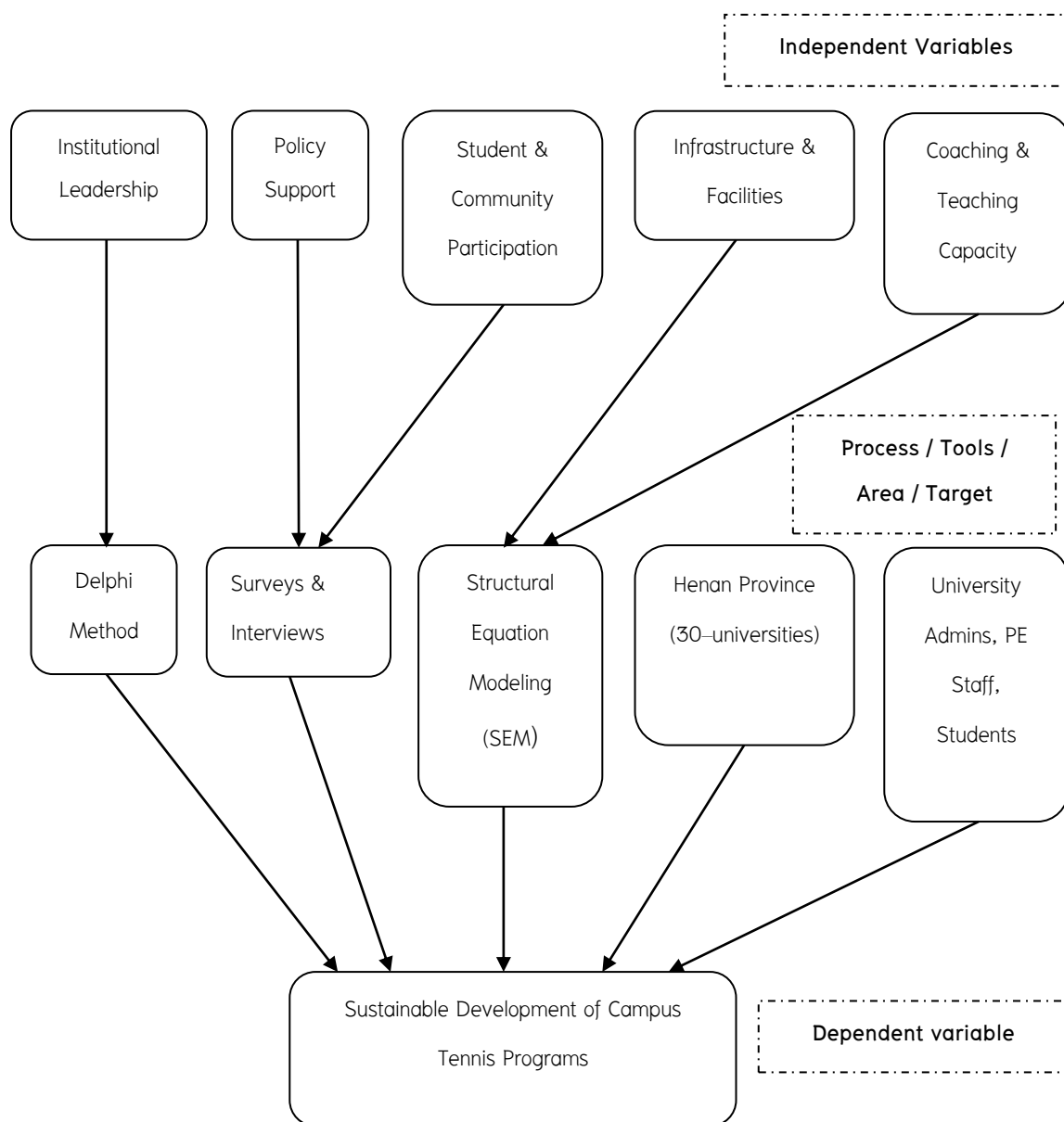


Figure 1 Conceptual Framework

Research Methodology

In order to investigate and evaluate the elements impacting the long-term growth of campus tennis programs in Henan Province, this study used a mixed-methods research design. Three phases of the study were carried out: document analysis and theoretical synthesis, Delphi expert consultation, and quantitative validation using structural equation modeling (SEM).

The study first established the conceptual framework and identified potential indicators of sustainability in campus tennis programs by reviewing government policies, research articles, and

existing documents. These metrics were categorized under areas like infrastructure, coaching quality, student engagement, and institutional support. The researcher developed a set of indicators that would subsequently direct data collection and analysis based on this framework.

The Delphi method was used to improve and validate these indicators. 15 professionals with backgrounds in policy development, sports management, and physical education were purposefully chosen to serve on the panel. Three rounds of expert consultation were held. While the second and third rounds concentrated on evaluating the significance and viability of each suggested factor, the first round used open-ended questions to gather suggestions. When at least 80% of the panel agreed that the indicators were significant, consensus was reached.

A structured questionnaire was created after the Delphi process and sent to university administrators, physical education teachers, and student leaders from 20 to 30 universities in Henan Province who were involved in campus tennis programs. Purposive sampling was used, and participants were chosen based on their geographic diversity and the existence of tennis-related activities.

The content validity and reliability of the questionnaire were examined in a pilot study. Relevance and clarity were evaluated using the Content Validity Index (CVI), and internal consistency was measured using Cronbach's Alpha, with a value of α 0.85 deemed acceptable.

Descriptive statistics, confirmatory factor analysis (CFA), exploratory factor analysis (EFA), and structural equation modeling (SEM) were used to analyze quantitative data. Standard indices like the chi-square/degrees of freedom ratio, TLI (Tucker-Lewis Index), CFI (Comparative Fit Index), and RMSEA (Root Mean Square Error of Approximation) were used to evaluate the model fit.

Strict adherence to ethical protocols was maintained. All respondents gave their informed consent, and participation was entirely voluntary. Throughout the study, confidentiality and anonymity were maintained.

A thorough grasp of how campus tennis programs can be developed sustainably in the context of Chinese higher education is provided by the study's methodology, which guaranteed both theoretical robustness and empirical reliability.

Research Results

1. To evaluate the state and difficulties of Henan Province's campus tennis programs. According to the findings, campus tennis programs at the sampled universities in Henan Province were generally in a moderate state of development. The survey subjects include 40 tennis coaches, 150 campus tennis professional school tennis team athletes, and 41 parents of students, and university administrators:

Institutional Commitment and Policy Support: While the majority of universities stated that they had general policies that supported physical education, only 37% had institutional plans or funding specifically for tennis. Tennis was not given the administrative attention it deserved because more popular or competitive sports were frequently given priority.

Infrastructure and Facilities: Standard tennis courts were available to only 45% of the institutions, and frequently they were unmaintained, shared with the general public, or devoid of the required equipment. The quantity and caliber of tennis-related activities were restricted by this scarcity.

Coaching and Human Resources: Certified tennis coaches or instructors with specialized training in tennis pedagogy were absent from more than half of the institutions (54%) as well. Due to their generalist backgrounds, the majority of physical education teachers were unable to provide specialized tennis instruction.

Student Involvement: Although 62% of students said they were interested in tennis, only 24% said they regularly played the sport. Lack of time, restricted access to courts, and a lack of promotional events were among the obstacles.

Community and Parental Involvement: There was very little participation from outside parties like parents and neighborhood tennis clubs. Less than 15% of schools supported their tennis programs through collaborations with neighborhood organizations.

In conclusion, the results indicate that although Henan's campus tennis program has a solid base, its primary obstacles are a lack of specialized coaching, poor infrastructure, a lack of policy attention, and a lack of community involvement. The sustainability and scalability of tennis as a fundamental part of university physical education are hampered by these factors.

2. To use empirical data and SEM analysis to identify important factors influencing campus tennis's sustainable development. According to the findings, the suggested conceptual framework's validity was validated by structural equation modeling (SEM), which also identified five key elements that had a major impact on the long-term growth of campus tennis programs in Henan

Province. Both expert consensus (obtained through the Delphi method) and survey data (n = 231) were used to derive these factors.

Evaluation of Model Fit

The following indices showed that the model as a whole fit the data well: $\chi^2/df = 1.87$ RMSEA = 0.045 CFI = 0.962 TLI = 0.951 SRMR = 0.037

These metrics attested to the model's suitability for interpretation and statistical acceptability.

Table 1 Standardized Coefficients of Key Factors Affecting the Sustainable Development of Campus Tennis (SEM Analysis Results)

Factor	Standardized Coefficient ($\hat{\beta}$)	p-value	Significance
Institutional Support	0.61	< .001	High
Coaching Quality	0.48	< .001	High
Student Participation	0.42	< .01	Moderate
Infrastructure & Facilities	0.34	< .05	Moderate
Community Involvement	0.26	< .05	Low

The findings of a structural equation modeling (SEM) study that was conducted in Henan Province to determine and assess the impact of five major factors on the long-term viability of campus tennis programs are shown in this table. P-values indicate levels of statistical significance, and the coefficients (β) show the direction and strength of relationships. The greatest impact was exhibited by institutional support, which was followed by coaching effectiveness and student involvement. At $p < .05$, every factor was statistically significant.

To sum up, the multifaceted sustainability model for campus tennis programs was confirmed by the SEM analysis. The results highlight the importance of student-centered participation strategies, qualified coaching staff, and policy-driven support in attaining long-term sustainability. These realizations offer a useful starting point for creating all-encompassing strategic plans and legislative initiatives.

3. To offer workable tactics and policy suggestions for improving the sustainability of the program.

A set of useful tactics and policy recommendations were developed to improve the long-term viability of campus tennis programs in Henan Province, according to the results, based on

expert consensus (Delphi method) and the empirical findings from the SEM analysis. These tactics deal with the programs' managerial, structural, and participatory elements.

1) Fortifying Institutional Governance and Policy

The development of tennis programs at universities should be governed by formalized policies that include performance evaluation, strategic goals, and allocated funding. Along with other popular sports, tennis must be given priority by institutional leadership, and a campus tennis coordinator must be appointed to supervise its implementation.

2) Enhancing Facility Access and Infrastructure

Standard tennis courts that satisfy national safety and usability standards should be upgraded or built with financial support. Efficiency and public involvement can be raised by multipurpose usage tactics, such as sharing use with nearby communities during off-peak hours.

3) Improving Curriculum Integration and Coaching Quality

The quality of instruction will be raised by incorporating tennis into general physical education classes and employing qualified tennis coaches. To increase long-term teaching capacity, it is also advised to provide PE teachers with professional development opportunities.

4) Using Incentive-Based Activities to Encourage Student Engagement

Universities should set up recreational competitions, reward-based physical activity programs, and intramural tennis leagues to increase student involvement. Ambassador programs and workshops run by peers can also promote wider participation.

5) Fostering Parental Involvement and Community Partnerships

Extended support networks can be established through cooperation with neighborhood tennis clubs, educational institutions, and parents. In order to co-host tennis events, share facilities, and create outreach initiatives, universities should form alliances with community stakeholders.

6) Coordination at the Provincial Level and Policy Alignment

Campus tennis should be incorporated into regional strategic plans by provincial education and sports departments. To monitor progress, exchange best practices, and give universities with strong program performance targeted funding support, a province-wide evaluation system can be created.

In conclusion, the suggested tactics are based on both theoretical frameworks and empirical data, and they are customized to the particular circumstances of Henan Province. If put

into practice, these tactics have the potential to greatly increase the viability and efficacy of campus tennis programs, setting an example for other Chinese provinces and beyond.

Discussions

The study's conclusions advance knowledge of how Henan Province's campus tennis programs can promote sustainable development. In line with earlier research that highlighted the importance of strategic leadership and policy prioritization in sports development initiatives, the findings demonstrated that institutional support is crucial to the long-term success of such programs (Zhang et al., 2022).

Student engagement and program sustainability were found to be significantly impacted by the caliber of coaching. This backs up the findings of Liu et al. (2023), who showed that having coaches who are certified and professionally trained is essential to boosting student interest in and involvement in campus athletics. The findings of self-determination theory in sports motivation, which holds that intrinsic motivation is increased when students feel competent, autonomous, and connected, were also supported by the finding that student participation was a strong predictor of program sustainability (Deci & Ryan, 2000).

Even though the effects of infrastructure and community involvement were relatively weaker, their importance cannot be understated. According to earlier studies, program inclusivity and scalability can be significantly increased by having access to secure, well-maintained facilities and local support systems (An et al., 2022). Therefore, especially in areas with limited resources like Henan, these domains shouldn't be left out of strategic planning.

The suggested conceptual framework is strongly supported by the combination of empirical validation via SEM analysis and Delphi expert consensus. In line with Li et al. (2022) suggestions for integrative methodologies in education-based sports research, this multi-method approach raises the research's legitimacy and practical applicability.

In conclusion, the study adds to the body of literature by placing sustainability considerations in a framework unique to tennis and offering practical suggestions adapted to Henan Province's conditions. For policymakers, sports educators, and institutional leaders looking to create more inclusive and long-lasting campus athletic programs, these findings can be a useful resource.

New Knowledge from Research

A conceptual synthesis highlighting five key knowledge areas that support the long-term growth of campus tennis programs was developed as a result of the research findings. Every element works together to support strategic implementation in educational institutions, especially Henan Province's universities.

First, institutional support and policy are fundamental. By using governance procedures and strategic planning, it guarantees that campus tennis gets enough attention. Effective program sustainability is more likely at universities with formal policies, long-term goals, and administrative oversight.

Second, providing effective tennis instruction depends heavily on the caliber of the coaching. The study found that in order to ensure that teachers have the pedagogical competence and technical skills necessary to effectively engage students, educational institutions must fund coaches' professional development.

Third, student participation contributes to sustainability as well as being a result of it. Higher levels of long-term success are reported by programs that incorporate tennis into student life through engagement activities, such as clubs, campus tournaments, and leisure activities. These exercises foster a culture of regular participation and increase student motivation.

Fourth, the physical viability of tennis activities is determined by infrastructure and facilities. Universities must set aside funds for facility management and investment to guarantee that students have access to top-notch courts and equipment. Additionally, well-kept facilities open doors for outside collaborations and community involvement.

Fifth, parental and community involvement was found to be a contributing factor. This study discovered that community partnerships, like partnering with nearby tennis clubs and outreach initiatives, can greatly strengthen the university's tennis ecosystem, particularly in areas with limited resources, despite the fact that this has been less stressed in earlier research.

Achieving the Sustainable Development of Campus Tennis Programs is the main objective, and all of these elements are directly related to it. Stakeholders can address both internal institutional factors and broader community dimensions thanks to the visual model that shows how each knowledge domain relates to particular strategic recommendations. For legislators, college officials, and sports educators looking to increase the influence and durability of tennis programs in higher education, this synthesis offers a useful road map.

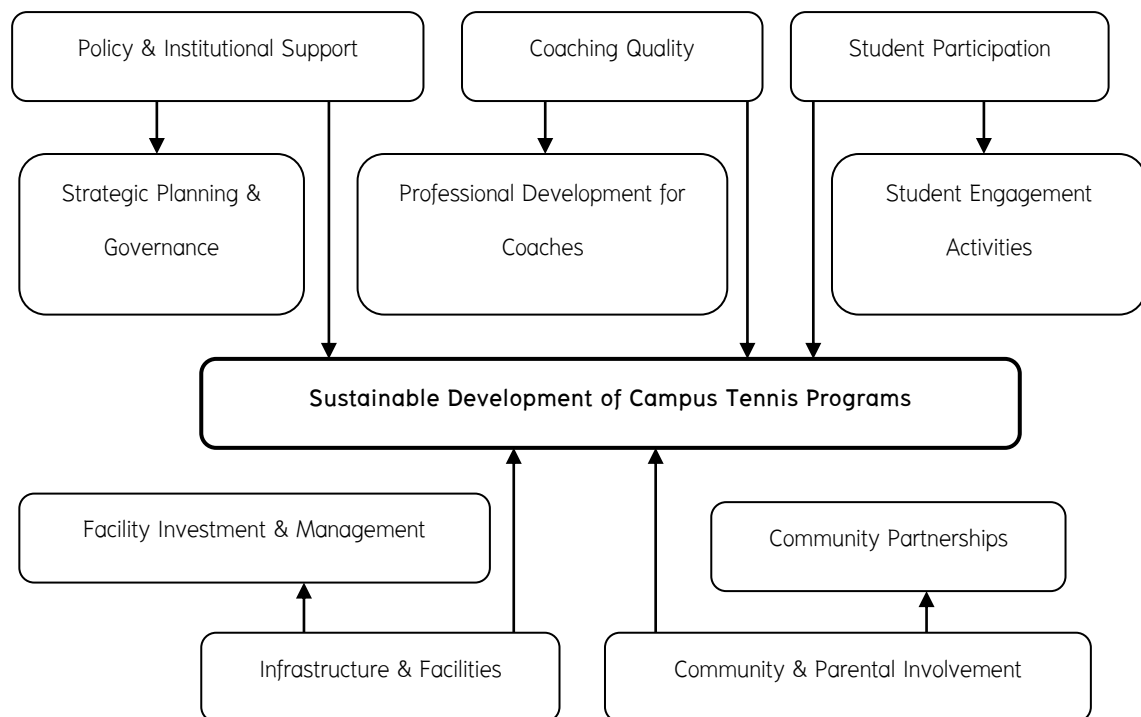


Figure 2 Conceptual Model Linking Strategic Domains to the Sustainable Development of Campus Tennis in Higher Education

Conclusion

Through a combination of expert consultation and empirical analysis, this study examined the factors influencing the long-term growth of campus tennis programs in China's Henan Province. Five crucial elements were identified by the study using a mixed-methods approach that included the Delphi technique and Structural Equation Modeling (SEM): community involvement, coaching quality, student participation, infrastructure and facilities, and policy and institutional support.

The results showed that program sustainability was most significantly impacted by institutional support, highlighting the importance of long-term planning and administrative leadership. Student involvement and coaching quality also had a significant impact, highlighting the value of highly qualified teachers and engaging teaching methods. Even though community involvement and infrastructure had comparatively smaller statistical effects, they are still crucial in practice, especially in areas with limited resources like Henan.

The study made a number of strategic recommendations in response to these findings, such as formalizing tennis policies, investing in facility improvements, implementing coach training

programs, creating student-centered activities, and forming community partnerships. It is anticipated that these tactics will improve campus tennis programs' long-term effects and operational quality.

In the end, this study advances scholarly knowledge of sustainable sports development in higher education and offers a framework tailored to a particular context that can help colleges, legislators, and sports professionals create inclusive and robust campus tennis programs. The model created here might also act as a guide for comparable initiatives in other nations or provinces looking to match physical education with more general sustainability objectives.

Suggestions

1. To ensure long-term commitment and integration into instructional strategies, universities should set clear institutional policies and set aside specific funds to support the sustainable growth of campus tennis programs.

2. To enhance teaching efficacy and boost student engagement, educational institutions must make coaching development investments by hiring certified tennis instructors and providing ongoing professional training.

3. To increase outreach, exchange resources, and improve the social impact of campus tennis initiatives, cooperation with community stakeholders—such as regional sports organizations and local tennis clubs—should be improved.

References

- An, Y., Yang, J., Niu, S. J., & Wang, J. (2022). Health First: the sustainable development of physical education in Chinese schools. *Sustainability*, 14(5), 3133. <https://doi.org/10.3390/su14053133>
- Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01
- Deng, S., Zhan, X., Lyu, C., & Saibon, J. B. (2023). Sports motivation in Chinese college students: A systematic review. *Heliyon*, 9(9), e22518. <https://doi.org/10.1016/j.heliyon.2023.e22518>
- Lahouel, B. B., Taleb, L., Managi, S., & Abaoub, N. (2023). Inclusive green growth in OECD countries: what are the impacts of stringent environmental and employment regulations? *Environmental Economics and Policy Studies*. <https://doi.org/10.1007/s10018-023-00362-4>

- Li, P., Wang, W., Liu, H., Zhang, C., & Hastie, P. A. (2022). *The impact of sport education on Chinese physical education majors' volleyball competence and knowledge*. *Sustainability*, 14(3), 1187. <https://doi.org/10.3390/su14031187>
- Liu, Z., Duan, X., Cheng, H., Liu, Z., Li, P., & Zhang, Y. (2023). *Empowering high-quality development of the Chinese sports education market in light of the "double reduction" policy: A hybrid SWOT-AHP analysis*. *Sustainability*, 15(3), 2107. <https://doi.org/10.3390/su15032107>
- Luo, Y., & Wang, F. (2025). Current situation and optimization path of university tennis clubs. *Frontiers in Sport Research*, 7(3), 61–66. <https://doi.org/10.25236/FSR.2025.070311>
- National Sports Authority China. (2023). *Annual report on campus sports activities*. Beijing: National Sports Authority China.
- Zhang, T., Wei, S.-Y., Liang, B.-B., & Zhu, J.-M. (2022). Research on Sustainable Development of Competitive Sports in China. *Frontiers in Psychology*, 13, 925909. <https://doi.org/10.3389/fpsyg.2022.925909>