



Research on the Sustainable Development Path of the Urban Community 15-Minute Fitness Circle Empowered by AI Smart Sports

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ABSTRACT

As the national fitness-for-all strategy has been implemented, the “15-minute fitness circle” Has largely achieved full coverage of urban communities, is now at a critical stage of transitioning from basic availability to high quality. The rapid advancement of artificial intelligence (AI) technologies has provided new momentum for this transition. this study focuses on AI smart sports empowering the urban community 15-minute fitness circle. It systematically reviews the current application of AI technologies in community fitness scenarios, analyzes their driving effects in terms of facility intelligence, service personalization, and data-driven management, and reveals the practical challenges including low data quality, insufficient technical adaptability, unclear operational models, and deficiencies in age-friendly design.

1. Background

As building a sporting powerhouse and a Healthy China constitute key development objectives in the new era, the rapid inroads of artificial intelligence into livelihood sectors are generating new drivers for the upgraded development of national fitness. In 2024, the State Council issued the Guiding Opinions on Deepening the Implementation of the “AI+” Initiative, which promotes the deep integration and large-scale application of artificial intelligence across all sectors, thereby charting a clear direction for the development of smart sports.

Since the implementation of the 14th Five-Year Plan for National Fitness, the 15-minute fitness circle has been largely established in urban communities across the country, effectively alleviating the shortage of fitness facilities for residents.

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However, as the scale of construction expands, problems such as low facility utilization rates, lagging operation and maintenance, inadequate elderly-friendliness, and singular operational models have become increasingly prominent, undermining the long-term sustainability of the 15-minute fitness circle. Driven by both policy guidance and practical needs, “AI + sports” has emerged as a key approach to overcoming development bottlenecks and advancing the improvement of the fitness circle. Here is the academic English translation: Taking Chengdu as an example: in Yixin Lake Subdistrict, Shuangliu District, interest classes organized around smart outdoor fitness paths attract over 1,000 elderly participants per week; at Dong’an Lake Smart Sports Island in Longquanyi District, facilities such as smart sports stations, AR motion-sensing devices, and smart running tracks allow citizens to record their exercise data through facial recognition. These implementations have provided richer and more convenient venues for nationwide fitness, thereby responding to the 14th Five-Year Plan for National Fitness.

2. Research Significance

Theoretical Significance: Current research on the "15-minute fitness circle" has largely centered on spatial layout and facility configuration, with insufficient attention devoted to the issue of long-term stable operation driven by AI technologies. This study bridges two policy priorities— "Artificial Intelligence Plus" and the "15-minute fitness circle"—and examines the collaborative modalities between technological support and sustainable operation, thereby contributing to enriching the theoretical system of smart sports and public sports service management.

Practical significance: Amid the critical period of formulating the 15th Five-Year Plan, this study, by dissecting typical practical cases, identifies the key bottlenecks that hinder the long-term stable operation of smart fitness facilities. The findings provide decision-making references for government departments to optimize the layout and operation of smart sports facilities, offer directional guidance for enterprises exploring sustainable business models, and deliver operational recommendations for communities to enhance the quality of smart sports services.

3. Literature Review

3.1 Research Progress on the 15-Minute Fitness Circle

Since the concept of the "15-minute fitness circle" was first introduced in 2014, related research has continued to deepen. Early studies predominantly employed GIS-based spatial analysis as the core methodology, concentrating on the spatial distribution of facilities, service accessibility, and coverage efficiency, with a primary focus on addressing the issue of "whether there are enough fitness facilities." As construction has progressed, the research emphasis has gradually shifted toward soft indicators such as service quality, usage efficiency, and resident satisfaction. The transition "from availability to quality" and "from construction to management" has become the mainstream research direction.

3.2 Research Status of AI-Enhanced Sports Services

Research on the application of artificial intelligence in social sports services is still at an exploratory stage. Existing studies can be broadly classified into two categories. The first is technology application research, which focuses on the realization of functions such as motion posture recognition, health data monitoring, and personalized fitness guidance. The second is service model research, which examines the role of digital-intelligent technologies in reshaping the supply modes of sports services. Within these two streams, Cheng Yufei proposed that the precise

integration of digital-intelligent technologies into community sport and health services involves five key stages—precise identification, design, integration, supply, and evaluation—offering a theoretical reference for the present study.

3.3 Insufficient Research from the Sustainability Perspective

Current research on AI sports predominantly focuses on technical functionalities and short-term outcomes, with insufficient systematic exploration of sustainability. The sustainable development of community fitness circles should encompass four core dimensions: long-term facility operation and maintenance, data security assurance, universally accessible and affordable services, and sustainable business models. Most studies concentrate on “what technology can do,” while lacking in-depth analysis of “how to ensure long-term stable operation.” Taking this as a point of departure, this paper integrates the sustainability concept throughout the entire research process.

4. Methodology

4.1 Research Methods

(1) Literature Research Method

This method systematically reviews national and local policy documents related to the National Fitness Program, AI+, and smart cities; collates academic findings on the 15-minute fitness circle and AI-powered sports services; and collects industry reports and practical cases to grasp policy orientations and research frontiers.

(2) Case Analysis Method

Typical domestic smart sports practice cases are selected for analysis, including: the “AI + HarmonyOS Sports Cluster” in Pingshan, Shenzhen; the “Digital-Integrated Medical-Sports” system in Yangpu, Shanghai; the smart fitness trail in Jinan Forest Park; and a set of applications in Chengdu, namely an outdoor smart gym, a smart sports campus, a smart sports station, and a smart track. The replicability of this model lies in its coverage of different technical approaches and operational models.

(3) Comparative Analysis Method

The typical cases are compared along three dimensions—technical direction, operational model, and management approach—so as to distill the common patterns and differentiated experiences of how smart sports empower the community fitness circle, and to identify the key elements for sustainable development.

4.2 Research Procedures

This study is conducted in four phases:

Phase 1: Literature review and core concept definition, and the construction of a three-dimensional analytical framework encompassing technology, operation, and management.

Phase 2: Collection of basic case information, technical applications, operational data, and management models to build a case database.

Phase 3: Diagnosis of bottlenecks constraining sustainable development through comparative case analysis.

Phase 4: Establishment of a synergistic development path, followed by the writing, revision, and finalization of the paper.

5. Results and Discussion

5.1 Data Analysis Before and After the Implementation of AI Smart Sports in the Fitness Circle

In recent years, the intervention of AI smart sports in the 15-minute fitness circle has not only substantially increased the number and area of fitness venues, but also enhanced sports participation and the physical fitness of the population, providing more convenient sports services for office workers, the elderly, and children. Taking national data as the macro context and Chengdu's local data as the core evidence, the comparative data between 2020 (before the large-scale implementation of AI smart sports) and 2025 (after implementation) are presented in Table 1.

Comparison Dimension	2020	2025
Per capita sports venue area	2.20 m ² (end of 2020)	3.11 m ² (end of 2025)
Number of national sports venues	3,713,400 (end of 2020)	5,003,700 (end of 2025)
Total output of sports industry	RMB 2,737.2 billion	RMB 3,842.1 billion
National physical fitness qualification rate	No publicly available data	84.9%
Proportion of people regularly participating in physical exercise	37.2% (residents aged 7 and above)	38.52% (residents aged 7 and above)

Data sources: General Administration of Sport of China, Bulletin of the Survey on the Status of National Fitness Activities (2020) and (2025); Bulletin of the Sixth National Physical Fitness Monitoring Survey; and publicly available data from Data Story of 2025 National Fitness (Hubei).

From the above data, it can be concluded that, driven by national policies, AI smart sports demonstrate a highly promising development prospect within the fitness circle. Participation in national fitness has steadily increased, the population regularly engaging in physical exercise has continued to expand, and the physical fitness of the population has gradually improved. These macro-level changes are strongly correlated with the concurrent and vigorous promotion of the “15-minute fitness circle” and the construction of AI smart sports. Although it is difficult to attribute the entire incremental gains solely to AI technology, the data indicate that, over the five-year period of synchronized smart sports development, the national fitness system as a whole has exhibited a healthy, rapid, and sustainable development trend. This provides a credible macro context for subsequent research on the specific contributions of AI smart sports

5.2 Practical Effectiveness of AI Smart Sports in Driving the Community Fitness Circle

Traditional fitness equipment, characterized by single-function designs and a lack of interactivity and guidance, struggles to meet residents' needs for scientific exercise. AI technology transforms ordinary fitness equipment into smart terminals that integrate data collection, analysis, and feedback. Taking Chengdu's AI smart fitness communities as an example: in Nanshan

Community, Huayang Subdistrict, Tianfu New Area, an idle pond was converted into an “outdoor smart gym” equipped with 5G- and IoT-enabled physical testing kiosks and self-powered smart training devices. The system collects physical fitness indicators, exercise performance data, and body composition analyses; users can scan a QR code to generate a personalized “exercise prescription” and create an individual “exercise profile,” thereby shifting from “blind training” to “scientific training.” The back-end system subsequently adjusts the fitness plan based on data feedback. Within less than a month of operation, the facility attracted over a thousand visits per day on average, with equipment queuing up during peak evening hours. The transformation of a previously hazardous pond into a popular gym effectively revitalized the city’s “golden corners and silver edges” (previously underutilized spaces), significantly enhancing the community environment quality and the utilization rate of public facilities. In Yixinhu Subdistrict, Shuangliu District, smart fitness trails were installed in newly built parks and communities, and smart adaptations were introduced specifically for elderly sports services. By scanning a code, elderly users can receive low-intensity, scientifically formulated exercise guidance tailored to their needs, breaking down information barriers for the elderly and ensuring healthy aging. Furthermore, relying on these smart facilities, the community offers over ten interest classes with a total weekly participation exceeding 1,000 visits. With the intervention of AI technology, fitness facilities are no longer outdated and impersonal.

5.3 Realistic Dilemmas Facing Sustainable Development

Insufficient data interoperability among departments of sports, health, and civil affairs, combined with inconsistent data standards adopted by equipment vendors from different manufacturers, undermines the training and practical effectiveness of AI models. The collection of sensitive data such as facial recognition and movement trajectories lacks unified regulations, creating risks in privacy protection and data security. The construction of smart sports facilities relies heavily on government fiscal investment, with a widespread tendency to emphasize construction while neglecting operation and maintenance; operating entities remain undefined and funding is unsecured. Market-oriented operation models have not yet matured, social capital participation remains low, and models such as “hardware plus services” and “supporting sports with commerce” are still at the exploratory stage, making long-term self-sustainability difficult to achieve.

AI smart sports involve multiple government departments including sports, health, civil affairs, housing and urban-rural development, and industry and information technology, with unclear divisions of responsibility and underdeveloped coordination mechanisms, resulting in considerable difficulty in policy alignment and resource integration. Only a small number of regions have realized a deep integration of sports and health, while the majority have yet to establish an efficient collaborative management system. Other studies have noted that while artificial intelligence can extend sports practices by reshaping the spatial-temporal conditions of sport and deepening subjective engagement, excessive technological reliance may also lead to the dissolution and alienation of subjectivity. Therefore, the construction of smart sports needs to strike a balance between technology and humanity, avoiding the tendency to pursue “technology for technology’s sake.”

5.4 Establishing the Sustainable Development Path

The age-friendly upgrading of smart fitness equipment should be accelerated by adopting simplified designs such as voice interaction, one-touch operation, and large-font interfaces, thereby lowering the usage threshold for the elderly population. The secure sharing of sports, medical, and

health data must be promoted. Governments should integrate smart sports into community public service planning and improve the standards for construction, operation and maintenance, and acceptance, while strengthening policy and financial safeguards. Technology enterprises should be guided to participate in facility operation, and market-oriented models such as free hardware, paid services, and value-added services should be explored. Communities should cultivate teams of sports instructors and volunteers to assist residents in using smart devices, thus enhancing service accessibility.

At the level of sustainable development, a comprehensive evaluation system should be established, incorporating indicators such as facility utilization rate, user retention rate, health improvement outcomes, operational break-even, and age-friendly coverage ratio. Internationally, previous studies have systematically discussed how technologies such as AI, the Internet of Things, and digital twins can reconstruct the sports community ecosystem, covering core issues such as data governance, inclusive design, and public–private partnerships. These discussions provide international theoretical and comparative references for the sustainable development framework proposed in this study.

6. Conclusions and Recommendations

6.1 Main Conclusions

This study concludes that AI smart sports, in empowering the 15-minute fitness circle, has evolved into four mainstream models: the smart trail, the community smart gym, the integration of sports and health, and the smart transformation of Olympic legacy. Each model exhibits distinctive characteristics in terms of technology application, operational approach, and target user groups.

Sustainable development now faces four major challenges: insufficient age-friendliness, data security risks, immature business models, and inadequate inter-departmental collaboration. Among these, age-friendliness represents the key technological bottleneck, the business model constitutes the operational core, and data management and inter-departmental collaboration serve as the institutional safeguards.

To achieve long-term development, it is essential to synergize technology, operation, and management. Specifically, the technological foundation should be strengthened through age-friendly design and data interoperability; operational approaches should be refined through diversified investment and market-oriented innovation; and management effectiveness should be enhanced through sports-health integration and departmental coordination.

6.2 Policy Recommendations

Integrate smart community sports into the basic public service guarantee system for national fitness under the 15th five-year plan. Mandate the implementation of age-friendly and child-friendly construction standards for smart sports facilities. Establish a diversified operational model featuring government guidance, market operation, and community participation. Deepen the integration of sports and health and incorporate ai-based exercise prescriptions into primary-level health management.

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