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A development Management Process to implement smart Sports in Higher Education Institutions in Heilongjiang Province, the People's Republic of China

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Abstract

Background and Aim: Currently, education is entering a rapid stage of development in smart education. Starting in 2015, research on the comprehension and application of smart education has received notable recognition in academic circles. It has actively and effectively contributed to advancing a fresh phase of educational reform and enhancing educational progress. This research aims to construct the developing strategies to implement smart sports in higher education institutions in Heilongjiang Province.

Materials and Methods: The participants in this research can be divided into four groups, which are as follows: (1) 20 teachers and 400 students were selected to participate in answering the questionnaires; (2) 7 experts were invited to in-depth interviews; (3) 19 experts were invited to conduct two-round Delphi study; and (4) 9 experts were invited to discuss and confirm the developing strategies to implement smart sports in higher education institutions in Heilongjiang province, based on POLC framework. Descriptive statistics, such as the calculation of the mean and standard deviation, are employed to assess the questionnaire data. The consensus data was analyzed by using the median and interquartile range. The criteria for analysis were a median of ≥ 3.50 and an interquartile range of ≤ 1.50.

Results: the factors for the developing strategies were divided into four aspects as follows: 1. Planning, which includes Development Strategy which consists of 5 factors; 2. Organizing includes basic support which consists of 6 factors, and physical education curriculum integration setup and implementation which consists of 9 factors; 3. Leading includes a Sports Learning Environment which consists of 5 factors; and 4. Controlling includes Sports big data monitoring and evaluation which consists of 6 factors and Sports services and management which consist of 7 factors.

Conclusion: The final development strategies for implementing smart sports in higher education institutions in Heilongjiang Province were acceptable.

Keywords: Smart Sport; Higher Education Institutions; Management Strategy; POLC

Introduction

Currently, education is entering a rapid stage of development in smart education. Starting in 2015, research on the comprehension and application of smart education has received notable recognition in academic circles. It has actively and effectively contributed to advancing a fresh phase of educational reform and enhancing educational progress (Dong & Tao, 2019). In today's context, the advancement of informatization has found its way into everyday teaching practices. The ongoing development of smart education within schools can progressively lead to digital self-sufficiency, resulting in the creation of a networked platform for educational resources. This aspect is pivotal in contemporary education and should not be underestimated (Wang, et al, 2021). In contrast to other fields of study, physical education places a strong emphasis on repetitive physical exercises for students. In the digital age, students can access a variety of sports instructional videos online and actively participate in physical exercises independently. This has significant advantages in fostering students' autonomy and overall competence.

As an integral part of education, higher education sports should first adapt to the inevitable laws of educational development. Combining the professionalism and uniqueness of higher education sports, it is essential to initiate theoretical exploration and practical research in smart higher education sports. This will effectively address the real challenges faced by higher education sports. Looking at the internal requirements of higher education sports education, it becomes apparent that the design and structure of higher education sports programs are no longer in sync with the student's needs and the demands of the modern era. Traditional teaching approaches no longer suffice to meet the contemporary standards for physical education, encompassing curriculum content, instructional methodologies, and evaluation techniques. Moreover, extracurricular exercise models fail to adequately engage students and ignite their enthusiasm. Competition organization follows a rather

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repetitive pattern, with a notable absence of comprehensive planning and promotion for campus sports events (Ye, 2018). The utilization of large sports facilities is suboptimal, lacking well-defined procedures for reservations, security, and facility maintenance. Physical fitness monitoring and assessment are confined to data feedback, missing targeted analysis, and solutions. There is insufficient monitoring of high-level sports team training, and the management practices within the sports department are outdated, characterized by a lack of systematic and collaborative innovative thinking. The resolution of these challenges hinges on strategic planning in higher education sports and robust support from modern information technology, thus advocating vigorously for the advancement of intelligent sports in higher education (Dou, et al, 2018).

In summary, in recent years, the educational landscape has witnessed a rapid surge in the development of smart education, with a notable focus on its comprehension and application since 2015. The integration of informatization into teaching practices has become a prevalent trend, particularly in the context of smart education within schools, paving the way for digital self-sufficiency and a networked platform for educational resources. However, the field of physical education stands out with its emphasis on repetitive physical exercises, benefitting from the digital age's accessibility to sports instructional videos for independent student engagement. Recognizing the need for adaptation, higher education sports now demand theoretical exploration and practical research in smart education, addressing challenges related to outdated teaching approaches, curriculum misalignment, and inadequate engagement strategies. Overcoming these challenges calls for strategic planning and robust support from modern information technology to propel the advancement of intelligent sports in higher education.

This study centers on various aspects of college smart sports, including online learning, sports big data mining, digital campus construction, college sports resource management, and the impact of information systems on college smart sports. Drawing theoretical support from education system theory and information system theory, we leverage relevant theories to address challenges encountered in the practical implementation of smart sports in Heilongjiang colleges and universities. Moreover, at present, a gap exists between the progress of smart technology in higher education sports and the theoretical advancements in various aspects of higher education sports. Therefore, within the framework of smart education, conducting developing strategies to implement smart sports in higher education institutions in Heilongjiang Province enables us to extract and condense the fundamental attributes of smart higher education sports from specific practical experiences. Consequently, this can offer valuable insights to enrich higher education sports theory and foster the growth of smart sports practices in higher education institutions.

Objectives

Main objective

To construct the developing strategies to implement smart sports in higher education institutions in Heilongjiang Province

Subsidiary objectives

(1) To analyze the components of smart sports in higher education institutions in Heilongjiang province and explain their internal relationships.

(2) To construct the theoretical operation mechanism of the components of smart sports in higher education institutions in Heilongjiang province.

(3) To confirm the developing strategies to implement smart sports in higher education institutions in Heilongjiang Province.

Literature Review

1. Smart

Smart in a narrow sense is a biologically advanced comprehensive ability based on the neural organs (material basis), including knowledge, judgment, understanding, association, culture, and other abilities. If one possesses smart and has the analytical, thinking, and exploratory abilities to understand the current situation deeply, including the past, future, things, and people, among others (Liu & Ma, 2015). In a broad sense, smart is composed of multiple systems, including aesthetics and evaluation, methods and skills, non-intelligence, intelligence, concepts, and thoughts. (Tang, 2013). Wisdom is rooted in a knowledge system and represents the capacity to tackle problems. As a result, it encompasses a knowledge system while also surpassing it. It's crucial to underscore that wisdom is a

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holistic system formed by the convergence of capabilities and resources. In simpler terms, it functions as both a skillset and a valuable resource.

Ronghuai (2018) proposes that within the field of computer science, the term "smart" can be comprehended through two dimensions: context and understanding. This understanding evolves through a process starting from data, progressing to information, then to knowledge, and ultimately culminating in wisdom. He contends that the stages of human knowledge acquisition, viewed from the dimension of comprehension, involve processes like research, absorption, manipulation, interaction, and reflection. These stages can also be simplified as the ongoing exploration of data by the human brain. Specifically, data focuses on gathering specific elements, information emphasizes relationships among multiple elements, knowledge centers on the formation of a holistic understanding, and wisdom places significant emphasis on interactions among various wholes.

However, the understanding of smart in foreign contexts stems from three distinct terms: "smart", "intelligent" or "wisdom". In English descriptions of smart, these three words carry distinct meanings that should be understood in particular life contexts and semantic environments. "Smart" denotes the capacity to adapt human decisions using computer technology and electronic sensors. On the other hand, "intelligence" signifies the level at which individuals handle novel situations or challenges, exhibit a higher degree of strategic thinking, and possess the ability to readily acquire or comprehend new knowledge and phenomena. "Wisdom" refers to having a good sense and judgment, as well as possessing appropriate or rational knowledge. Therefore, these three words each have different emphases and should be matched with the appropriate word based on the context (Yang & Wang, 2018).

Currently, the new generation of information technology, exemplified by the Internet, big data, and artificial intelligence, is experiencing significant and far-reaching growth, profoundly impacting the economic development, societal advancement, and daily lives of nations worldwide. The United Nations has issued a white paper on big data, heralding the arrival of the big data era. China is diligently keeping pace with the current trends. The onset of the big data era has injected fresh momentum into China's economic innovation and development, fostering ongoing progress in the field of education, and creating a more conducive environment for the advancement of all sectors of society. Consequently, innovations in physical education at colleges and universities must seize this big data era and ensure that career innovations yield satisfactory outcomes (Yuan, 2021).

2. Smart Education

The core of smart education is information-based education, where teachers are encouraged to embrace the principles of information-based education and actively employ innovative sports education methods, making use of resources such as computers, network technology, and communication technology that are accessible within the school (Ma, 2022). Smart education has had a significant impact on traditional education. It places a stronger focus on leveraging new media technology and big data technology to enhance education through technological integration, precision, and quantification. Additionally, smart education is implemented within intelligent environments and follows a holistic model that encompasses technological expertise, tools, and content. It boasts features like automation, openness, and scalability, with the education process itself serving as a wellspring of curriculum resources. This aligns with the educational philosophy that the process itself serves as the ultimate goal (Yu, 2023)

The research in smart education is advancing swiftly, evolving from traditional in-person instruction to online and remote learning methods. Smart education offers e-learning courses aimed at enhancing personalized education systems, designed to identify and assess the distinct learning styles, educational requirements, and academic goals of individual students. Therefore, incorporating interactive sessions into video tutoring classes can significantly enhance a student's active learning experience. These interactions are valuable tools for teachers to evaluate student performance, ultimately leading to improved teaching standards and more efficient content delivery (Hemaranjani, 2023).

According to Ye & Wei (2011), within the context of the development of smart education, smart sports can be described as encompassing the utilization of modern information technology, various sensors, terminals, and intelligent processing technologies like cloud computing. These technologies enable a more comprehensive and digitized perception and analysis of sports activities. Consequently, this advancement leads to more intelligent responses and decision support for various societal needs, including competitive sports, fitness for all, sports venues, and facilities, thereby enhancing the overall management and services related to sports. Smart education is a product of the deep intersection of various intelligent technologies and education and gradually develops into the main direction of

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education development in the era of technological change. Smart education will lead the development of national education informatization and become an important development direction of future education informatization. According to the current literature research, the research on smart education can be divided into concepts and characteristics, development paths, system frameworks, smart curricula, and innovative practices of smart learning environments.

3. Smart sports in higher education institutions

The "2018 Action Plan for Education Informatization 2.0," released by the Ministry of Education, outlines the use of emerging technologies like artificial intelligence, big data, and the Internet of Things. It emphasizes the utilization of various intelligent devices and networks to actively engage in innovative research and demonstrations within the realm of smart education. This initiative aims to drive a transformation in educational models and the ecological restructuring of education with the support of these new technologies (Ministry of Education, 2018). In this context, educational methods that align with the era of internet big data are progressively emerging as more efficient teaching models. This has led to the emergence of a novel educational approach known as "smart education," which utilizes modern information technology to catalyze the rejuvenation of educational concepts (Wang, 2020). It represents an information-driven educational model that improves the teaching system and revolutionizes teaching methods. Smart education, powered by modern information technology, holds the potential to advance educational reform and development in China. When integrated into higher education physical education courses, information technology can modernize conventional teaching approaches. This aligns with the overarching "Internet + Education" trend and facilitates the implementation of a teaching model that integrates sports and education, substantially raising the standards of education informatization and intelligence (Zhu, 2019).

"Smart sports" represents a novel domain within sports informatization, resulting from the convergence of modern information technology and the sports industry. Its impact extends beyond enhancing the management capabilities of sports authorities and elevating the quality of public sports services. It also expedites the swift development of sports, informatization, and dramatization in China (Chen, et al, 2017). The development of smart sports harnesses advanced scientific technology to fundamentally overcome the constraints of real-time and spatial limitations in higher education sports. It allows students to achieve diverse venue transformations within the same location by integrating intelligent technology and scientific information technology. This grants them access to a broader spectrum of scientific analysis of human movement data, enhancing the precision of sports training and ultimately boosting athletes' technical skills. Smart sport is evident not only in the systematic implementation of artificial intelligence-based management systems for public sports facilities but also in the upgrading of intelligent equipment in school sports venues. The practical application of smart sports fields serves as a noteworthy case study in the advancement of smart sports (Liu & Huang, 2020)

4. Development Management

The swift advancements in technology and the growing focus on accountability in education have underscored the necessity for education management development. Management development is a subject of ongoing debate in theoretical discussions, drawing upon pertinent management principles and organizational theory. This concept originated within an industrial context, where it was seen as a factor contributing to enhanced productivity (Shah, S.J.A. 1999). Viewing educational institutions as organizations with defined objectives and recognizing "management development as an integral component of the organizational development process" (Mullins, 1995), placed significant importance on management development. This connection between organizational development, management efficiency, and outcomes highlighted the need to cultivate management potential to attain the desired objectives.

In an ideal scenario, management development in education should have the overarching goal of enhancing performance and effectiveness. This includes individual effectiveness, organizational enhancement, and, notably, the improvement of "pupil performance" (Elizabeth, 1986). There is a growing emphasis on the interconnectedness of management development with the institution's progress and outcomes (Brew, 1995). It is asserted that the quality of education may be compromised without effective management.

Today, organizations and managers encounter a central challenge: finding creative solutions to business problems. Management principles serve as valuable guidelines for managers to address these business challenges. These principles of management are typically grouped into four key functions: planning, organizing, leading, and controlling, collectively known as the P-O-L-C framework.

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The foremost task for a manager is to engage in creative problem-solving. To aid managers in effectively addressing this challenge, principles of management have traditionally been organized into four key functions: planning, organizing, leading, and controlling, commonly referred to as the P-O-L-C framework. In practice, these four functions, as depicted in the P-O-L-C figure, are intricately interwoven in the day-to-day operations of running an organization.

It's essential to acknowledge that this framework is not immune to criticism. In particular, these critiques arise from the observation that while the P-O-L-C functions may be ideal, they might not accurately represent the day-to-day actions of real-world managers (Mintzberg, 1973). A typical day in the life of a manager at any level can be fragmented and frenzied, often subject to the constant pressure of addressing the numerous less significant tasks alongside the crucial ones. Nonetheless, the prevailing consensus suggests that the P-O-L-C functions of management still offer a valuable means of categorizing the activities managers undertake in their pursuit of organizational objectives (Lamond, 2004).

Conceptual Framework

The conceptual framework of this research is as follows:

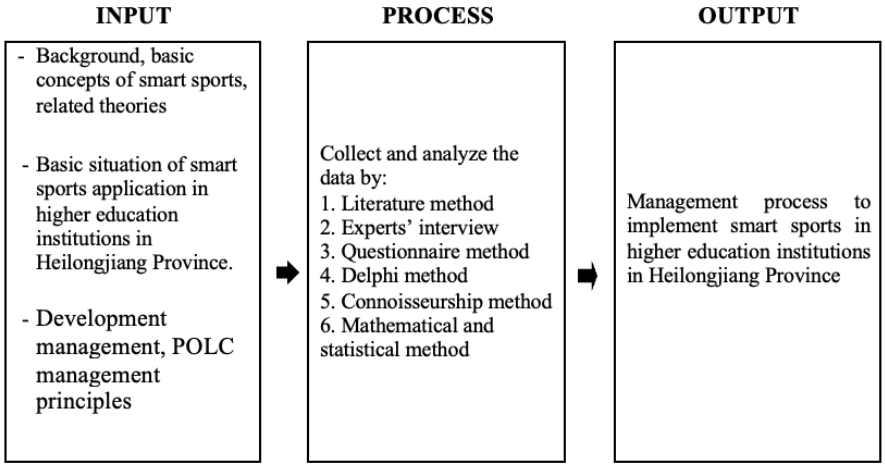

Figure 1: Conceptual framework of the research

Methodology

1. Research Tools

In this research, the research tools are as follows: (1) Questionnaires for the survey method; (2) Questionnaires for the Delphi method; (3) Interviewing Form.

2. Population and Sample

In this study, participants can be categorized into four distinct groups, which are as follows:

First Group: Participants in the questionnaire survey method

The participants of this group were selected by purposive sampling method, including 20 teachers related to the management of smart sports applications, such as teachers in college, teachers in university, and relevant administrators. 400 students involved in smart sports applications in Heilongjiang Province.

Second Group: Participant in experts' interview

The participants of this group were 7 experts, selected by purposive sampling method. The experts for this group included 3 smart sports applications management experts, 2 university teachers, and 2 university administrators for an in-depth interview, to draft the developing strategies framework to implement smart sports in higher education institutions.

Third Group: Participants for the Delphi method

The participants of this group were 19 experts, selected by snowball sampling method. The experts for this group were as follows:

7 smart sports applications management experts, with more than 5 years of work in the field of smart sports applications management.

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7 university teachers, with more than 10 years of work in the field of physical education.
5 university administrators, with more than 5 years of work in the field of sport.

Fourth Group: Participants in the Connoisseurship method

The participant of this group was 9 experts, selected by purposive sampling method. The experts for this group included 3 experts related to the management of smart sports applications, 3 university teachers, and 3 university administrators.

3. Data Collection

1. The surveys completed by teachers and students who are involved in smart sports applications in Heilongjiang Province were gathered and subjected to analysis.
2. 7 experts were in-depth interviewed to study the implementation of smart sports applications in higher education institutions and formulate a policy for its utilization.
3. Drafting the developing strategies framework to implement smart sports in higher education institutions.
4. 19 experts conducted two rounds of Delphi consensus to construct the developing strategies framework based on the POLC management principles.
5. 9 experts conduct connoisseurship to discuss and confirm the development strategies to implement smart sports in higher education institutions in Heilongjiang Province.

4. Data Analysis

1. Descriptive statistics, such as the calculation of the mean and standard deviation, are employed to assess the questionnaire data.
2. The consensus data was analyzed using descriptive statistics, specifically median and interquartile range. The criteria for analysis were a median of ≥ 3.50 and an interquartile range of ≤ 1.50.
3. Assess the content validity of the questionnaire by employing the Indexes of Items of Objective Congruence (IOC). IOC value = 0.87
4. Utilize Microsoft Excel for data collection and organization from the questionnaire.
5. Employ specialized software packages for data analysis.

Results

1. Find out the requirements and the current situation of using smart sports in higher education institutions in Heilongjiang Province

1.1Questionaries survey for teachers

Using a questionnaire star, 20 teachers were invited to participate in a questionnaire survey, and all 20 completed questionnaires were successfully retrieved, achieving a 100% recovery rate.

Table 1: the questionnaire survey on teacher requirements for smart physical education in higher education institutions

Questionnaire Items	Distribution of people in each option					Total Score	
	5	4	3	2	1	$\bar{x}$	S.D.
1. Remotely implement video monitoring	8	6	3	2	1	3.90	1.18
2. AI visual recognition identity authentication system for sports venues	10	5	2	2	1	4.05	1.20
3. Menu-style physical education courseware production	7	7	4	2	0	3.95	0.97
4. Interactive classroom organization forms such as flipped classrooms, physical education micro-class, private broadcast classes, and maker	8	7	2	2	1	3.95	1.16
5. After-school student exercise exchange group (After-school network)	7	7	5	1	1	4.05	0.67
6. Stadium sports video recording and live broadcast hardware	10	6	2	2	1	4.25	0.77
7. On-demand online course content on the touch screen in the venue	9	8	2	1	0	4.25	0.83

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Questionnaire Items	Distribution of people in each option					Total Score	
	5	4	3	2	1	$\bar{x}$	S.D.
8. Live online video playback of course teaching	11	6	1	1	1	4.25	1.09
9. Sports venue space and functional electronic reading screen	12	5	2	1	0	4.40	0.86
10. The online resource platform provides independent learning evaluation	11	8	1	0	0	4.50	0.59
11. Online evaluation of extracurricular sports competitions and activity organizations	9	9	1	1	0	4.30	0.78
12. A comprehensive physical education course learning platform	10	7	1	1	1	4.20	1.08
13. Intelligent recording and broadcasting of campus sports events, live streaming at any time and sharing anywhere	11	8	1	0	0	4.50	0.59
14. Online evaluation of extracurricular venue services	12	6	1	0	1	4.40	0.97
15. Multi-scenario virtual media response training room	9	8	2	0	1	4.20	0.98
16. Big data on individual sports competitions, including participation, performance statistics, and technical statistics	7	6	4	2	1	3.80	1.17
17. Online reservation of companions and random selection of companions for physical education and exercise	8	8	3	1	0	4.15	0.85
18. Crowd distribution indicator screen in the venue	13	5	1	1	0	4.65	0.81
19. Big data on daily physical exercise, including statistics on heart rate activity, load, and intensity in each class	10	8	2	0	0	4.40	0.66
20. Online learning and dissemination platform for various sports and health exercise knowledge, sports functions and exercise methods	9	7	3	1	0	4.20	0.87
21. Big data on physical education class exercise, including statistics on heart rate activity, load, and intensity in each class	11	6	2	1	0	4.35	0.85
22. Course evaluation of special skills and basic physical fitness in the learning process	12	5	3	0	0	4.45	0.74
23. Online promotion and organization of various competitions, and independent query of competition results	13	4	2	1	0	4.45	0.86
24. Sports venues achieve full network coverage	14	3	3	0	0	4.55	0.74
25. Campus sports comprehensive application platform (APP, etc.)	13	5	1	1	0	4.50	0.81
26. Venue instant messaging online support	11	7	1	0	1	4.35	0.96
27. Touch screen fitness equipment and fitness functions	15	3	2	0	0	4.65	0.65
28. Collect various campus sports big data information and easily present campus sports big data reports	10	7	2	1	0	4.30	0.84
29. Formulate a development vision for smart sports	8	8	2	1	1	4.05	1.07
30. Air index monitor in the venue	11	7	1	1	0	4.40	0.80

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Questionnaire Items	Distribution of people in each option					Total Score	
	5	4	3	2	1	$\bar{x}$	S.D.
31. Formulate a development plan for smart sports	12	5	1	1	1	4.30	1.10
32. Set development goals for smart sports	10	8	2	0	0	4.40	0.66
33. Sports venue reservation management platform	14	5	1	0	0	4.65	0.57
34. Formulate the development content of smart sports	12	4	2	1	1	4.25	1.13
35. Self-inquiry about venue usage status online	10	5	3	1	1	4.10	1.14
36. Implementation methods for smart sports	13	5	1	1	0	4.50	0.81
37. Smart stadium lighting and air conditioning	14	5	1	0	0	4.65	0.57
38. One-click alarm, precise fault location	15	4	1	0	0	4.70	0.56
39. In case of campus emergencies, the system automatically switches the alarm display	16	2	1	1	0	4.65	0.79
40. Fire, disaster, and sudden injury handling and emergency information broadcast	10	5	2	2	1	4.05	1.20

Based on the information presented in Table 1, the survey results indicate that for items such as "Remotely implement video monitoring", "Menu-style physical education courseware production", "Interactive classroom organization forms such as flipped classroom, physical education micro-class, private broadcast class, and maker", and "Big data on individual sports competitions, including participation, performance statistics, and technical statistics", the average demand scores all fall below 4.00, and their standard deviations exceed 0.97. This reveals a growing divergence in the current preferences of college students regarding these topics, implying significant disparity in the perspectives and requirements of various teachers on these matters, although, collectively, the demand for them remains at a relatively low level.

Teachers responded to questions such as "Sports venue reservation management platform", "Implementation methods for smart sports", "Smart stadium lighting and air conditioning", "One-click alarm, precise fault location", and "In case of campus emergencies, the system automatically switches the alarm display", the demand scores for these issues all reached 4.50 points or above. Furthermore, over half of those who expressed a strong interest in this topic in response to related questions demonstrate that teachers are deeply interested in the venue and the implementation methods for smart sports within higher education institutions.

1.3 Questionaries survey for students

Using a questionnaire star, 400 students were invited to participate in a questionnaire survey, and 375 completed questionnaires were successfully retrieved, achieving a 93.75% recovery rate. Furthermore, all 375 collected questionnaires were deemed 100% valid and effective

Table 2: the questionnaire survey on student requirements for smart physical education in higher education institutions

Questionnaire Items	Distribution of people in each option					Total Score	
	5	4	3	2	1	$\bar{x}$	S.D.
1. Remotely implement video monitoring	123	116	63	43	30	3.69	1.26
2.AI visual recognition identity authentication system for sports venues	131	97	65	61	21	3.68	1.26
3. Menu-style physical education courseware production	119	111	72	50	23	3.67	1.22
4. Interactive classroom organization forms such as flipped classrooms, physical education	120	107	74	50	24	3.66	1.23

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Questionnaire Items	Distribution of people in each option					Total Score	
	5	4	3	2	1	$\bar{x}$	S.D.
micro-class, private broadcast classes, and maker							
5. After-school student exercise exchange group (After-school network)	126	124	66	46	13	3.81	1.13
6. Stadium sports video recording and live broadcast hardware	130	104	57	67	17	3.70	1.24
7. On-demand online course content on the touch screen in the venue	127	119	60	47	22	3.75	1.21
8. Live online video playback of course teaching	131	115	65	46	18	3.79	1.18
9. Sports venue space and functional electronic reading screen	143	109	68	48	7	3.89	1.11
10. The online resource platform provides independent learning evaluation	130	126	63	41	15	3.84	1.13
11. Online evaluation of extracurricular sports competitions and activity organizations	138	127	69	34	7	3.95	1.04
12. A comprehensive physical education course learning platform	145	115	60	41	14	3.90	1.14
13. Intelligent recording and broadcasting of campus sports events, live streaming at any time and sharing anywhere	149	118	62	38	8	3.97	1.08
14. Online evaluation of extracurricular venue services	146	127	69	29	12	4.04	0.91
15. Multi-scenario virtual media response training room	168	112	60	25	10	4.07	1.05
16. Big data on individual sports competitions, including participation, performance statistics, and technical statistics	162	108	69	28	8	4.03	1.05
17. Online reservation of companions and random selection of companions for physical education and exercise	175	116	46	24	14	4.10	1.08
18. Crowd distribution indicator screen in the venue	184	90	53	43	5	4.08	1.10
19. Big data on daily physical exercise, including statistics on heart rate activity, load, and intensity in each class	181	107	58	18	11	4.14	1.04
20. Online learning and dissemination platform for various sports and health exercise knowledge, sports functions and exercise methods	146	129	76	19	5	4.05	0.96
21. Big data on physical education class exercise, including statistics on heart rate activity, load, and intensity in each class	174	103	74	18	6	4.12	0.99
22. Course evaluation of special skills and basic physical fitness in the learning process	177	119	56	16	7	4.18	0.96
23. Online promotion and organization of various competitions, and independent query of competition results	172	121	53	23	6	4.15	0.98

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Questionnaire Items	Distribution of people in each option					Total Score	
	5	4	3	2	1	$\bar{x}$	S.D.
24. Sports venues achieve full network coverage	206	77	50	35	7	4.17	1.09
25. Campus sports comprehensive application platform (APP, etc.)	182	99	53	30	11	4.10	1.10
26. Venue instant messaging online support	176	122	49	20	8	4.17	0.99
27. Touch screen fitness equipment and fitness functions	180	99	63	28	5	4.12	1.03
28. Collect various campus sports big data information and easily present campus sports big data reports	170	118	61	21	5	4.14	0.97
29. Formulate a development vision for smart sports	174	137	40	18	6	4.21	0.93
30. Air index monitor in the venue	196	107	45	26	3	4.26	0.92
31. Formulate a development plan for smart sports	187	134	35	14	5	4.29	0.88
32. Set development goals for smart sports	189	135	34	12	5	4.31	0.86
33. Sports venue reservation management platform	211	108	31	15	12	4.33	0.95
34. Formulate the development content of smart sports	190	138	30	12	5	4.32	0.85
35. Self-inquiry about venue usage status online	196	128	32	17	2	4.33	0.85
36. Implementation methods for smart sports	207	121	30	12	5	4.37	0.86
37. Smart stadium lighting and air conditioning	215	116	25	15	4	4.39	0.86
38. One-click alarm, precise fault location	216	112	34	11	2	4.41	0.81
39. In case of campus emergencies, the system automatically switches the alarm display	265	81	19	7	3	4.59	0.74
40. Fire, disaster, and sudden injury handling and emergency information broadcast	295	60	12	7	1	4.71	0.64

Based on the information presented in Table 2, the survey results indicate that for items such as “Stadium sports video recording and live broadcast hardware”, “After-school student exercise exchange group (After-school network)”, “Interactive classroom organization forms such as flipped classroom, physical education micro-class, private broadcast class, and maker”, “Menu-style physical education courseware production”, “AI visual recognition identity authentication system for sports venues”, and “Remotely implement video monitoring”, the average demand scores all fall below 3.80, and their standard deviations exceed 1.10. This reveals a growing divergence in the current preferences of college students regarding these topics, implying significant disparity in the perspectives and requirements of various students on these matters, although, collectively, the demand for them remains at a relatively low level.

Students responded to questions such as “Implementation methods for smart sports”, “Formulate the development content of smart sports”, “Set development goals for smart sports”, “Formulate a development plan for smart sports”, and “Formulate a development vision for smart sports”, the demand scores for these issues all reached 4.20 points or above. Furthermore, over half of those who expressed a strong interest in this topic in response to related questions demonstrate that college students are deeply invested in the future planning and establishment of smart sports initiatives within higher education institutions. This underscores that as college students actively involved in smart sports programs at their universities, they hold a profound concern for the advancement of smart sports in the academic setting. This heightened level of attention and demand not only reflects the strong interest of these students but also highlights the substantial vitality and demand for the development of smart sports in colleges and universities from a demand-driven perspective

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Furthermore, infrastructure related to venue services and management, as well as the training and learning environment, are also of significant concern to students. In this regard, aspects such as “Smart stadium lighting and air conditioning”, “Air index monitor in the venue”, “Self-inquiry about venue usage status online”, and “Sports venue reservation management platform”, the demand scores for these issues all reached 4.25 points or above. The proportion of respondents who selected "very necessary" for related surveys such as “Sports venues achieve full network coverage” and “Air index monitor in the venue” also was almost 50%, indicating that college students have a high level of interest in improving lighting and information infrastructure and services in sports venues. degree of demand.

The preceding survey reveals that college students, actively engaged in the implementation of smart sports within higher education, have unspoken concerns and desires related to both the theoretical and practical dimensions of smart sports in universities. This indirect insight underscores the current emphasis among college students on the practical utilization of smart technology. In response, the next logical step for university physical education departments should involve increased investment in the smart infrastructure and assessment of physical education programs and learning environments. This initiative aims to address the existing disparity and inadequacy between supply and demand.

2. Expert’s interview to gather information about using smart sports in higher education institutions in Heilongjiang Province

The results of interviews with experts indicate, firstly, that research on smart sports in colleges and universities is still in the exploratory stage, with limited reference cases for replication within the field. Therefore, it is recommended that we draw from the theoretical findings of research on constituent elements in related fields such as smart cities, smart transportation, and smart education. Secondly, in conjunction with insights gained from expert interviews, particularly in the current era of rapid information technology advancement, it is suggested to align with the inherent evolutionary path of “science - technology - engineering application” and the internal logical relationship of strategic planning, technological innovation, and platform application construction. This would provide a clear vertical alignment of the various components of smart sports within higher education institutions.

3. Delphi Method survey results

Following the first round of the Delphi survey method, the majority of factors related to implementing smart sports in higher education institutions have been accepted. However, some items did not receive approval and were subsequently excluded, and to confirm and validate these opinions, the researcher distributed a second round questionnaire to the experts, providing them with the consensus data and the researcher's decisions from the first round. In the second round of the Delphi survey, the remaining factors were 38 factors listed in the following table 3.

Table 3 Second round of Delphi results

No	Factors Relate to Implementing Smart Sports in Higher Education Institutions	Mdn.	IQR	Result
Planning (P)				
(1) Development Strategy				
1	Sports innovation	4.94	0.00	Retained
2	Strategic vision of university sports	4.36	1.00	Retained
3	The strategic focus of university sports	4.89	0.00	Retained
4	University sports tasks	4.73	0.00	Retained
5	Implementation of university sports strategy	5.00	0.00	Retained
Organizing (O)				
(2) Basic Support				
1	Internet	5.00	0.00	Retained
2	Information infrastructure	4.89	0.00	Retained
3	Cloud technology	4.73	0.00	Retained
4	Information technology	5.00	0.00	Retained
5	Artificial intelligence	5.00	0.00	Retained
6	Cloud (information) platform	5.00	0.00	Retained

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No	Factors Relate to Implementing Smart Sports in Higher Education Institutions	Mdn.	IQR	Result
(3) Physical Education Curriculum Integration Setup and Implementation				
1	Smart physical education classroom	5.00	0.00	Retained
2	Physical education teaching model	4.84	0.00	Retained
3	Physical education courseware	4.73	0.00	Retained
4	Smart sports learning	5.00	0.00	Retained
5	Physical education course evaluation	5.00	0.00	Retained
6	Ubiquitous learning	4.89	0.00	Retained
7	Independent learning	4.84	0.00	Retained
8	Physical education course goals	4.73	0.00	Retained
9	Physical Education teaching design	5.00	0.00	Retained
Leading (L)				
(4) Sport Learning Environment				
1	Smart sports venues	5.00	0.00	Retained
2	Physical education community	4.89	0.00	Retained
3	Intelligent sports tools	5.00	0.00	Retained
4	Sport learning resources	5.00	0.00	Retained
5	Sports learning community	4.84	0.00	Retained
Controlling (C)				
(5) Sports big data monitoring and evaluation				
1	Campus big data	4.89	0.00	Retained
2	Sports big data	4.84	0.00	Retained
3	Big data analysis	4.94	0.00	Retained
4	Sports data mining	4.89	0.00	Retained
5	Big data collection	5.00	0.00	Retained
6	Big data decision-making	4.84	0.00	Retained
(6) Sports services and management				
1	Educational information platform	5.00	0.00	Retained
2	Smart sports services	5.00	0.00	Retained
3	Sports remote management	5.00	0.00	Retained
4	Smart sports decision-making	5.00	0.00	Retained
5	Sports safety warning	4.84	0.00	Retained
6	Visual management	4.84	0.00	Retained
7	Sports Diagnosis	4.89	0.00	Retained

Therefore, it can be concluded that the 38 factors identified are the primary elements influencing the development strategies for implementing smart sports in higher education institutions in Heilongjiang Province. Following the second round of the Delphi survey, there was no need to remove, modify, or add any influencing factors.

Based on the outcomes of the second rounds of the Delphi method, all items adhered to the criteria of Mdn. ≥ 3.50 and IQR ≤ 1.50. Therefore, it can be concluded that all items were deemed essential and accepted to be incorporated into the model.

4. Confirmation of the development strategies for implementing smart sports in higher education institutions in Heilongjiang Province, by using the Connoisseurship method

After conducting a questionnaire survey, and expert interview, and collected the data through two rounds of the Delphi method. The researcher created the development strategies for implementing smart sports in higher education institutions in Heilongjiang Province.

To ensure the satisfaction, utility, and practicality of such development strategies, the researcher conducted the connoisseurship panel by inviting a total of 9 experts related to the management of smart sports applications, teachers in the university, and the relevant administrators, to participate in

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discussions to confirm the feasibility and reasonableness of the development strategies for implementing smart sports in higher education institutions in Heilongjiang Province.

Form the Connoisseurship panel. The development strategies for implementing smart sports in higher education institutions in Heilongjiang Province were acceptable, and the experts agreed to pursue the development strategies for implementing smart sports in higher education institutions in Heilongjiang Province and fully supported the university's use of this strategy.

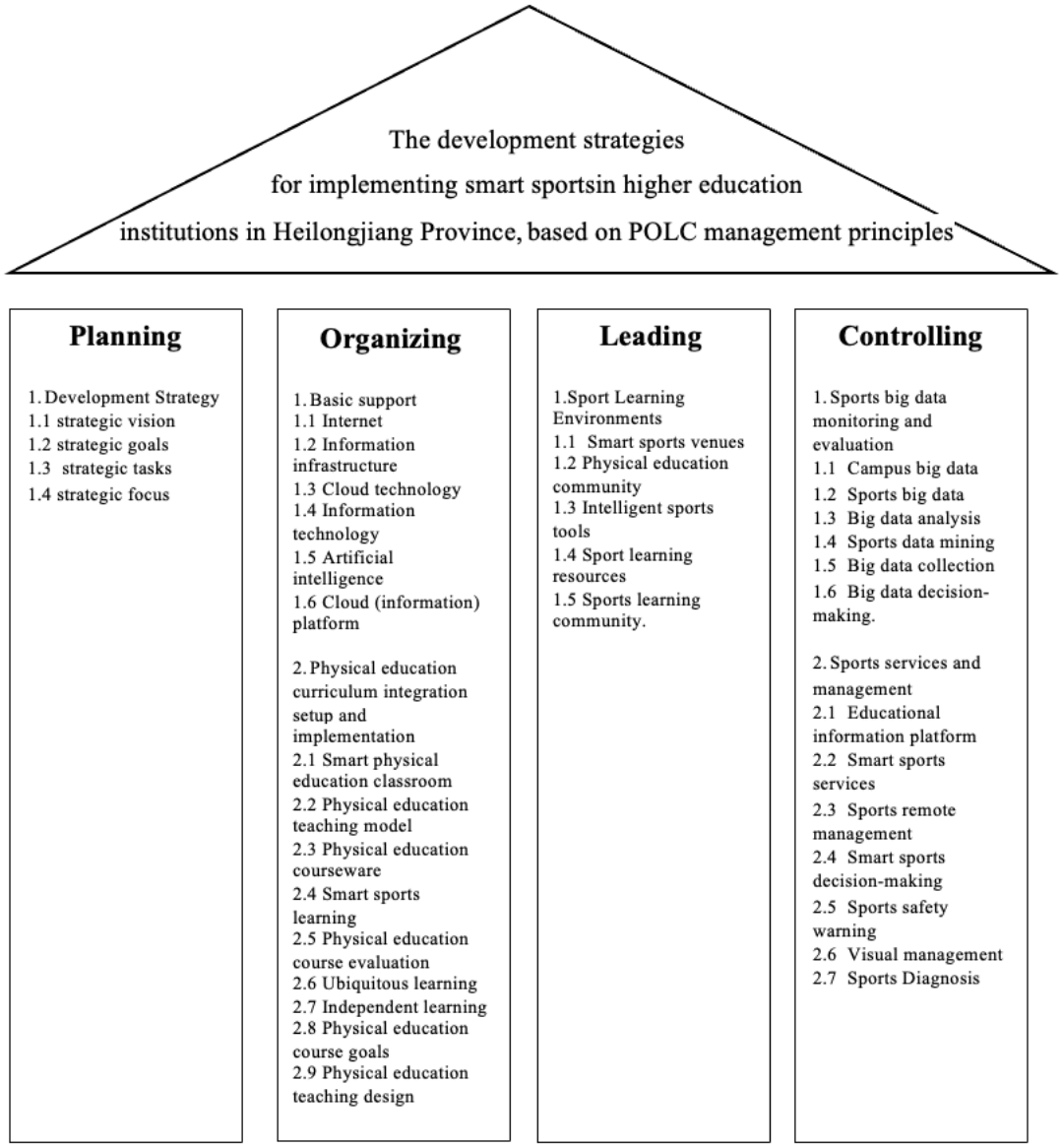

Figure 2 The development strategies for implementing smart sports in higher education institutions in Heilongjiang Province

Conclusion

After confirmation by the connoisseurship method, the final development strategies for implementing smart sports in higher education institutions in Heilongjiang Province were confirmed as follows:

1. Planning: In the context of planning, it includes a Development Strategy which consists of 5 factors as follows: (1) Sports innovation; (2) Strategic vision of university sports; (3) Strategic focus of university sports; (4) University sports tasks; and (5) Implementation of university sports strategy.

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2. Organizing: In the context of organizing, it includes basic support which consists of 6 factors as follows: (1) Internet; (2) Information infrastructure; (3) Cloud technology; (4) Information technology; (5) Artificial intelligence; and (6) Cloud (information) platform. Moreover, the context of organizing also includes physical education curriculum integration setup and implementation which consist of 9 factors as follows: (1) Smart physical education classroom; (2) Physical education teaching model; (3) Physical education courseware; (4) Smart sports learning; (5) Physical education course evaluation; (6) Ubiquitous learning; (7) Independent learning; (8) Physical education course goals; (9) Physical Education Teaching Design.

3. Leading: In the context of leading, it includes a Sports Learning Environment which consists of 5 factors as follows: (1) Smart sports venues; (2) Physical education community; (3) Intelligent sports tools; (4) Sports learning resources; and (5) Sports learning community.

4. Controlling: In the context of controlling, it includes Sports big data monitoring and evaluation which consist of 6 factors as follows: (1) Campus big data; (2) Sports big data; (3) Big data analysis; (4) Sports data mining; (5) Big data collection; and (6) Big data decision-making. Moreover, the context of controlling also includes Sports services and management which consist of 7 factors as follows: (1) Educational information platform; (2) Smart sports services; (3) Sports remote management; (4) Smart sports decision-making; (5) Sports safety warning; (6) Visual management; and (7) Sports Diagnosis.

Discussion

Integrating smart sports aligns with the broader trend of leveraging technology in education. It not only enhances the sports experience but also reflects the institution's commitment to embracing advancements that benefit both academic and extracurricular aspects of student life. Smart sports technologies can provide students with innovative and interactive ways to engage in physical activities. This engagement contributes to improved overall health and well-being, fostering a more active and energetic campus environment.

Based on the research results, from the developing strategies for implementing smart sports in higher education institutions in Heilongjiang Province constructed by using the POLC management principles show that in term of bringing smart sports to use at the university level, is not only about using electronic media in teaching but also involves various management processes, including learning environment and various services. This is consistent with the research result of Ye & Wei (2011) which state that in the context of the evolution of smart education, smart sports can be characterized as the integration of contemporary information technology, diverse sensors, terminals, and intelligent processing technologies such as cloud computing. These technologies facilitate a more thorough and digitized understanding and analysis of sports activities. As a result, this progress leads to more intelligent responses and decision support across a spectrum of societal needs, encompassing competitive sports, universal fitness, sports venues, and facilities. Consequently, it enhances the overall management and services associated with sports. Smart education emerges from the profound intersection of various intelligent technologies and education, gradually evolving into the primary direction of educational development in this era of technological change.

In addition, the research on developing strategies for implementing smart sports in higher education institutions in Heilongjiang Province, utilizing the POLC (Planning, Organizing, Leading, Controlling) management principles, reveals a comprehensive perspective on integrating smart sports at the university level. The findings highlight that the implementation of smart sports goes beyond the mere incorporation of electronic media in teaching; it encompasses a range of management processes. The POLC framework, a widely recognized management model, is employed to guide the planning, organization, leadership, and control aspects of introducing smart sports in higher education. This implies that successful integration involves strategic planning, efficient organization of resources, effective leadership to drive the initiative, and robust control mechanisms to monitor and evaluate the implementation process (Daft, 2018; Robbins & Coulter, 2019).

The research underscores the significance of addressing not only the technological aspects but also the broader managerial dimensions, such as creating an optimal learning environment and ensuring the availability of various supporting services. By adopting the POLC management principles, higher education institutions can systematically approach the implementation of smart sports, fostering a holistic environment that enhances both the technological and organizational aspects of this initiative. This research contributes valuable insights for universities seeking to leverage

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smart sports in their educational programs, emphasizing the need for a multifaceted approach that aligns with established management principles.

Recommendation

Recommendation for current research

1. Higher education authorities must thoroughly acknowledge and leverage the roles and functionalities of smart sports within colleges and universities.

2. Collaborate with academic departments beyond sports science, such as computer science, business, and psychology. Explore interdisciplinary approaches to enhance the management process and provide students with a holistic experience.

3. Develop strategies for public awareness campaigns to inform and educate the community about the benefits of smart sports initiatives. Highlight the positive impact on health, education, and overall well-being to garner support and participation.

Recommendation for further research

1. Compare the implementation of smart sports in higher education institutions across different provinces or regions in China, considering variations in infrastructure, culture, and institutional policies.

2. Investigate the role of faculty and staff in the success of smart sports initiatives, exploring how their engagement and support contribute to a positive and inclusive sports culture.

3. Conduct longitudinal studies to evaluate the sustained impact of smart sports initiatives on the well-being and academic performance of students over an extended period.

4. Explore the development of policy and governance frameworks that support the responsible and ethical use of smart sports technologies within educational settings.

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