

## Research Article

# Intelligent Big Data Framework for the Technical Design of Public Management Applications in Sports

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Public sports services (PSS) are an important element in the development of China's public service industry and promoting theoretical research on PSS at the present time has just become an inevitable requirement for the development of sports. The main purpose of the work in this paper is the study of public management data in sport through intelligent big data analysis, with the participation of knowledge graphs, migrating relevant algorithms from other application areas, and optimizing them on this basis. It provides an objective review and analysis of the weaknesses of current sport public management research, etc. Based on informative data sources and in-depth theoretical analysis, it provides an objective description and analysis of the current situation of the development of sport public management services and an outlook on the future development of public sport services.

## 1. Introduction

Along with the implementation of a comprehensive fitness programmed outline on the basis of China's comprehensive economic, cultural, and social development, the aim is to meet the people's growing demand for sports, their pursuit of quality of life, their increased attention to sports and physical exercise, and their increasingly diverse requirements for public management of sports [1]. At the same time, China's government management is moving towards public service government management, and public services are something that governments at all levels attach great importance to [2]. Only by improving the public service management system can we provide more efficient and convenient public service content for the people [3, 4]. The growth and advancement of public service content, in turn, provides the necessary prefabricated solutions to the imbalance in public service provision that may arise in the future [5]. From the perspective of PSS, the development of PSS can promote the development of mass sports in China, which in turn is the basis for competitive sports, and thus enable China to develop towards a strong sports nation [6]. In this context, the improvement of PSS can serve the whole country and promote the healthy development of the whole

country, thus laying the foundation of human resources for the construction of a modern socialist country [7].

Public management of sport is itself an important part of social management, a management activity with sporting attributes in social management [8]. As various diseases gradually tend to become younger, and with them the people's concept of health deepens, the people are paying more and more attention to their own health [9]. Public management of sport itself is the basis for providing basic protection for people's health, and the main implementer and executor of public management of sport is only the government. The public management of sport provided by the government is a specialized management and service policy that responds to the needs of the public, and the public sport services provided by the government have become an essential part of people's daily lives [10].

The rapid development of technology in contemporary society has led to a very rapid increase in social productivity, which in turn has reduced the labor intensity of human labor and reduced working hours. The reduction in working time and the increase in leisure time have caused problems in the use of leisure time [11]. In the process of gradually promoting the construction of a well-off society in China, social attributes are changing, i.e., from a traditionally conservative

society to a developmental one. The public management activities of sport are being improved in the process of development, and the services provided are closely linked to the daily lives of the people, thus promoting the development of national fitness projects. Therefore, from the perspective of the people's needs and the general objective of a well-off society, we will vigorously develop PSS and promote the improvement of the fitness level of all people.

Technical means play a large part in determining the approach to academic scientific research, and therefore the adoption of finding the right technical means becomes particularly important [12]. Indeed, in the state of rapid follow-up by academics under the guidance of the National Plan for Philosophy and Social Sciences, the comprehensiveness and accuracy of data are very important in the process of visualizing and analyzing information, so it is all the more important that scientific research should make full use of advanced methods like technological information technology as a way of improving research. This paper focuses on the question of how information retrieval methods on public management of sport should be used to form a knowledge map of public sport services through intelligent big data methods that accurately reflect the relevant research lineage. We will also analyze the current situation of the development of public sports management and its problems, with a view to laying a solid foundation for its formation into a healthy development.

The arrangement of the paper is as follows: Section 1 includes the introduction of paper. Section 2 explains the present state of research in public management of sport. Section 3 talks about theoretical and technical foundations. It has some subsections to explain the topic very well. Section 4 explains the analysis of research hotspot and evolution patterns. Section 5 concludes the paper in well-mannered way.

## 2. Current State of Research in Public Management of Sport

The father of the Olympic Movement, Byrd Kubitan, originally proposed the concept of sport as "all sport for the masses," with the aim of "helping all citizens, regardless of age, gender, or profession, to recognize and understand the value of sport and to promote active participation in all kinds of physical activity throughout life" [13]. This laid the theoretical foundations for public sport. In the Declaration of the Fifth Congress of Mass Sport held in Uruguay in March 1994, the slogan "Sport for all, health for all" was put forward, signifying that public sport had become an important part of the development of sport. Since the 1990s, countries around the world have launched their own public sport development programmers, and the implementation of these programmers has drawn the attention of scholars to the study of public management of sport.

Marc C. pointed out the importance of sports clubs, mass sports events at the congress of the European Association of Sports Management [14]. He stressed that the public should be encouraged to pay attention to large-scale sporting events and that effective measures should be taken to increase the

popular interest in sporting events and to promote the effective management of mass sport.

Harry H. Hiller points out that sporting events can be more effective by using more technology, strong networks, emotional commitment, and more cultural benefits and that the staging of events may also improve the overall living conditions of citizens as well as their incomes in the long term, ultimately contributing to the economic growth of cities. At the same time, he analyzes the potential economic benefits generated by sporting events from an economic perspective [15].

Anna D. speaks about how although sports or any other type of physical activity can be recreational and beneficial to people's health, they can also become dangerous and hidden risks such as injury, danger or loss have always been unpleasant outcomes [16]. In order to minimize or even eliminate these risks, effective risk management is needed in the sport and leisure industry. He therefore suggests that appropriate risk management strategies and applications should be developed and points out that this is an important part of sport management systems.

Marco F. pointed out that the Olympic Games could provide a good opportunity for the development of a new form of public-private partnership, noting that the public sector should work more closely with the various socio-economic factors involved in the event [17]. The public sector should work more closely with the various socio-economic factors involved in the event. However, stakeholder involvement must be effective in order to facilitate innovative practices and the sustainable development of sporting events.

Karla A. Henderson examines different dimensions of recreational physical activity from a leisure scholar's perspective, exploring the organization and management of sports programmers and arguing that the health of individuals and communities can be promoted through interventions in people's participation in recreational sport [18].

Cucui G. G. has conducted a research study on football clubs through questionnaires and SWOT analysis, highlighting the need for scientific and effective management of football clubs through the optimization of internal club management systems, business performance, etc. [19].

## 3. Theoretical and Technical Foundations

*3.1. Introduction to the Knowledge Graph.* In recent years, we have moved from a focus on big data to intelligent data [20]. With the unprecedented amount of data available today, there is an urgent need to build a data model that reflects our own sophisticated understanding of information. Intelligent data semantic models that enable data inference become important, not only for their ability to automatically reason about retrieved data, but also to extend and complement known answers, allowing for a multidimensional perspective. The application of knowledge graphs (KG) allows machines to further grasp to the way humans communicate or think [21] and the ability to extend connections in knowledge to uncover the exact needs of the user. At the same time, the unique organization of data in the knowledge

graph allows data to be related to each other. Its “links” together the vast amount of disordered information on the Web, so that it is no longer bound by rigid rules in analysis and computation scenarios but is more intelligent and forms a set of semantic knowledge networks for the Web that are easy to understand and easy to compute. Many specific uses and applications rely on the knowledge graph. Examples include intelligent content and packaging reuse, responsive and context-aware content recommendation, knowledge graph-driven drug discovery, semantic search, literature retrieval, information discovery in the news, advanced drug safety analysis, etc.

The knowledge graph represents a collection of inter-related descriptions of entities (objects, events, or concepts) [22]. The knowledge graph puts data into context through links and semantic metadata, providing a framework for data integration, unification, analysis, and sharing of data. Knowledge graphs combine features of several data management models and incorporate knowledge features from different disciplines, for example, features in databases that enable the retrieval of data through structured data, features in graph theory for the analysis of data structured by networks, and features in knowledge bases that can be used to interpret data and infer data based on formal semantics.

Figure 1 shows the architecture of the knowledge graph from knowledge extraction to knowledge retrieval, with the boxed section showing the mainstream construction process of the knowledge network. One is a top-down approach, where the overall framework of the data is defined before the entities are populated and the data network is constructed. The other is a bottom-up approach, in which the data framework is extracted from existing data. In this paper, we also adopt a bottom-up knowledge graph network construction model, in line with the figure below; we extract knowledge from the core sports journals data on the Knowledge Network to obtain the basic node and edge Schema framework. The original data is then transformed to form a knowledge graph “network.” Once the global network data is available, a number of operations such as filtering and evaluation of the data are carried out to form a “clean” knowledge graph “network.” Finally, it can be used for various types of functional retrieval and algorithmic operations. In addition, the knowledge graph network needs to be continuously maintained, i.e., knowledge updated, so that the knowledge graph network is continuously expanded, and useless data is continuously removed.

**3.2. Graph Database Engine.** As we all know, graph database is known as the high-speed rail in the era of big data, and its concept is derived from graph, i.e., graph theory in mathematics, which is a relational network composed of nodes and relationships [23, 24]. In short, a graph database is a nonrelational database developed based on an extension of graph theory. It is a database system that provides for the storage, reading, and analysis of graph data.

The graph database engine in this paper is based on the Berkeley open-source project Janus Graph, a distributed graph database engine based on the graph database Tian,

which is being developed and distributed. Janus Graph is based on Tinker pop and has a flexible and highly extensible framework that supports multiple combinatorial models. Its advantages include the following:

- (1) Support for large amounts of graph data storage
- (2) Support for a large number of users to perform complex real-time traversal of graph data with high concurrency
- (3) Support for multidata center high availability and hot backup
- (4) Janus Graph that can be used to scale the size of the database in a cluster approach
- (5) In the case of high concurrency transactions being also managed and manipulated

And its transaction processing capacity is closely related to the size of the cluster. With the number of clusters supported, even if the total amount of data is very large, it is still possible to achieve millisecond response for complex data retrieval. The problem of slow queries due to the large network of nodes can be solved by setting up the index binding as a super node, thus solving the problem of slow queries through vertex queries. The Janus Graph engine architecture is shown in Figure 2.

**3.3. Big Data Framework.** The big data framework used in this paper is the Hive storage framework, whose main role is to store large amounts of data and batch data operations to ensure the efficiency of the data processing process. Hive is divided into four main modules. These include the user interface module, the metadata processing module, the driver module, and the Hadoop cluster module. The corresponding framework model is shown in Figure 3.

- (1) User interfaces

There are three main user interfaces for accessing Hive, suitable for different scenarios of Hive operation. WEBUI is a visual interface for managing Hive through a browser with a specified URL. The JDBC connection method, which is configured in Java, requires the introduction of the Hive matching jar package and the writing of specific code to add, delete, change, and check data.

- (2) Metadata services

Meta Store, a mediated data for the description of attributes of stored data or to aid data retrieval, is, in short, a service that allows metadata to be managed in a structured way.

- (3) Hadoop cluster

The underlying HDFS is used for data storage, including transaction preprocessing data, community segmentation data, and algorithm models. The role of MapReduce is to perform batch computation of data, and the storage level is the same as that of Hadoop, both of which can store large batches of data.

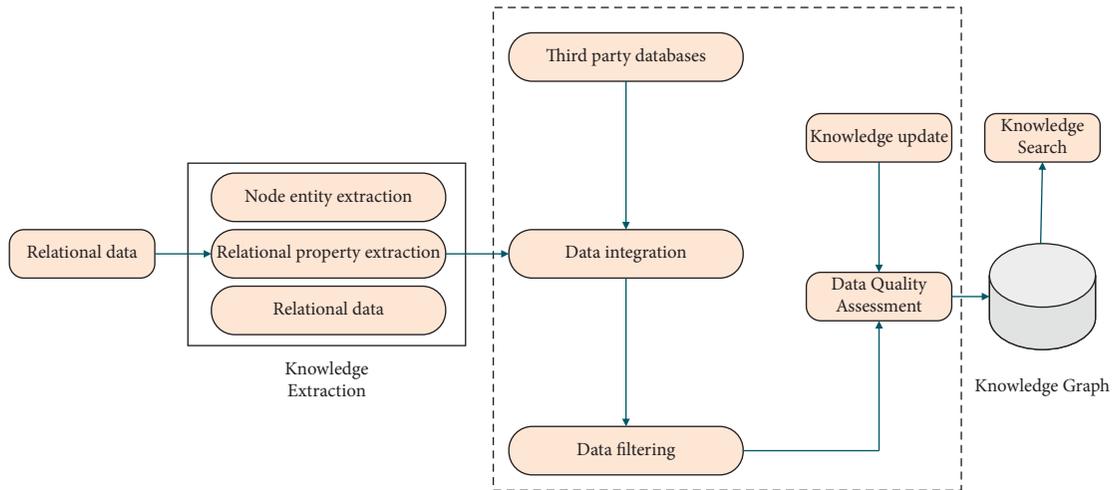


FIGURE 1: Knowledge graph architecture.

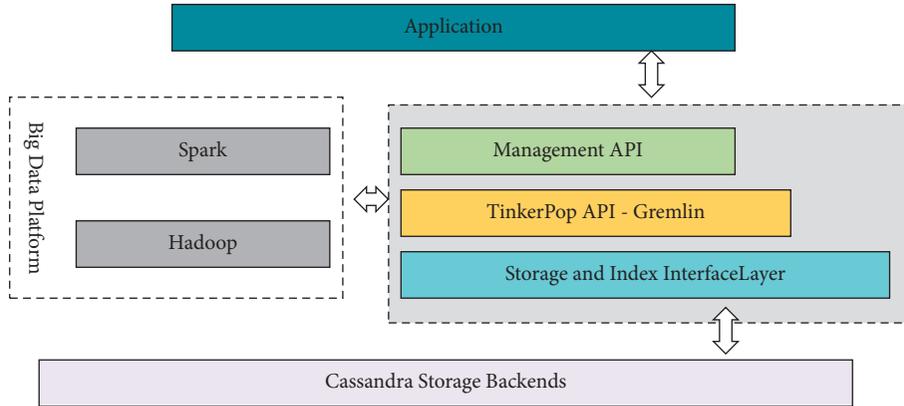


FIGURE 2: Janus Graph engine architecture diagram.

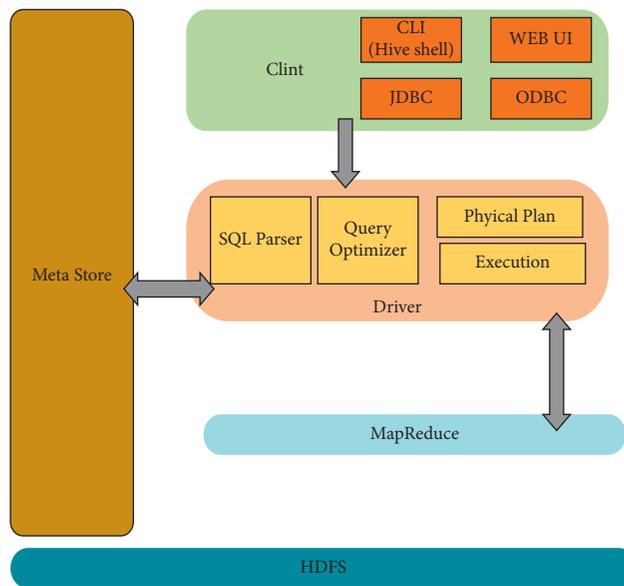


FIGURE 3: Big data framework diagram.

#### (4) Driver

The Driver is divided into four parts: the parser, compiler, optimizer, and executor. The main role of the parser is to convert raw string SQL statements into ASTs using various tools such as Antlr. The compiler takes the parsed AST abstraction syntax tree and compiles it into an execution list with a logical plan. The optimizer takes the resulting execution plan and further analyzes and adjusts it to produce a better execution plan. The executor takes the perfect execution plan, translates it into a machine language that the machine can recognize, and implements it. The default for Hive is the MapReduce task.

### 4. Analysis of Research Hotspots and Evolution Patterns Based on Intelligent Big Data

**4.1. Study Subjects.** The connotation and extension of sports public management are relatively broad. In terms of the connotation and management functions of sports, sports public management mainly includes sports industry management, sports human resources management, leisure sports management, small town sports management, urban sports management, sports club management, community sports management, social sports instructor management, sports event management, sports project management, and so on. The main object of this study is the literature on mass sports management from 2000 to 2021, which is included in the Chinese Social Sciences Citation Index (CSSCI) database.

**4.2. The Annual Evolution of Public Management Research in Sport in China.** Scientific literature is one of the most important forms of recording the results of scientific research and writing the necessary research literature is an important part of conducting scientific research. The amount of literature is an important indicator of research capacity in a particular field, and public sport management research literature is a summary of research findings and processes in the field and an important quantitative indicator of public sport management research. An in-depth econometric analysis of the sport public management research literature can help us to understand the development process and patterns of research in this field.

The volume of literature is the amount of literature that meets the requirements of a search based on the relevant constraints within a set period of time. The volume of literature in a particular discipline or research area is a direct reflection of the development of the relevant research work. Generally speaking, the more the literature is counted, the more mature the field of study is and the more attention it receives in social science research activities. Conversely, the lower the volume of research literature is, the less relevant the field of study is, and the more attention these potentially valuable disciplines need to receive from society. Figure 4 shows the annual trends in the publication of literature related to public management of sport in China.

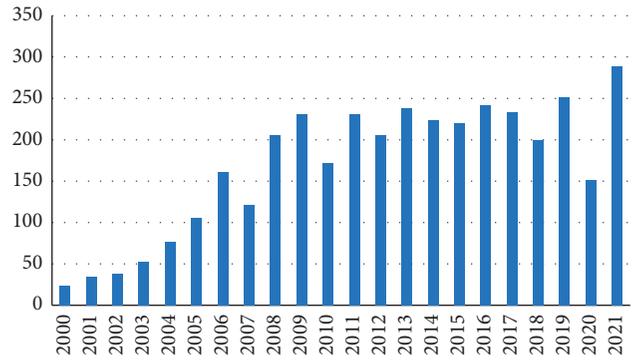


FIGURE 4: Annual trends in the publication of literature related to public management of sport in China.

Figure 4 shows that, from 2000 to 2021, research on mass sport management in China has generally shown a continuous upward trend in a wave pattern. The research on public sports management in China can be divided into two stages: the first stage is the primary development stage (2000–2007), which basically shows a slow annual upward trend. It can be seen that, with the promulgation and implementation of the programmatic document “National Fitness Plan Outline” in 1995 and the comprehensive implementation of the National Fitness Plan in 2000, the study of public management of sports gradually received the attention of scholars. The second stage is the rapid development stage (2008–2021), which indicates that the research on the management of public sports in China began to enter a period of mature development during this period, with greater progress in terms of depth and breadth.

**4.3. Distribution of Research Institutions in Public Management of Sport in China.** Researchers are generally affiliated with the corresponding research institutions, and a certain number of researchers together constitute the entity of the research institution. Throughout the research field of sports public management in China, well-known research institutions are stored in the minds of the public with their unique status and image. A visual metrological analysis of the research literature of research institutions in the field of mass sports management can well locate the main research institutions in this field, effectively measure the research effectiveness and progress of each research institution, and also help researchers discover benchmarks and find gaps from the level of institutions. Figure 5 shows the knowledge map of the highly productive research institutions in the field of mass sports management research in China. Different nodes in the figure represent different research institutions, different nodes consist of multiple circles, and the size of the overall node circle represents the number of total papers published by different institutions in Figure 5.

Figure 5 conversed about the division of research institutes in China and it expresses the facilities of researcher for working available at different places in China. There are different organizations for different type of research in China.

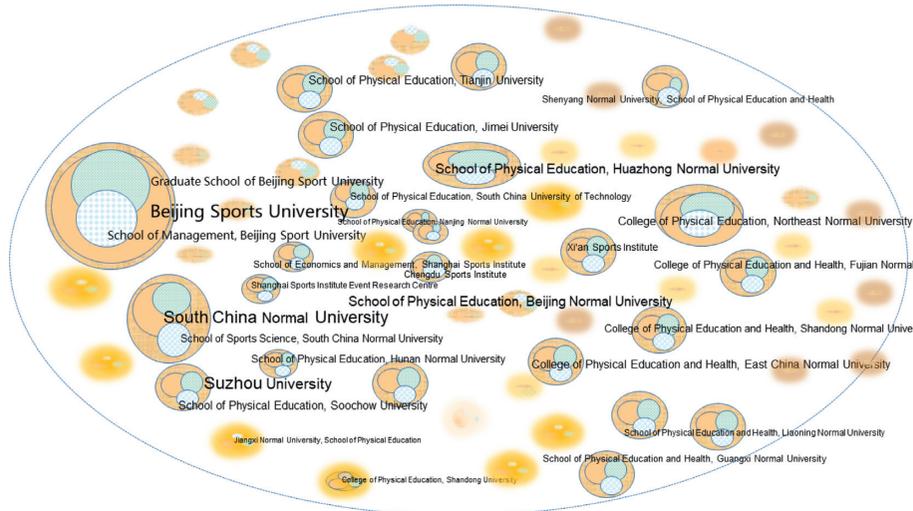


FIGURE 5: Distribution of research institutions in public management of sport in China.

*4.4. Analysis of Research Themes for Cooccurring Theme Words and Keywords in Public Management of Sport.* The keywords are a summary of the topic of the article and a distillation of the author's research focus, and they are very representative. Table 1 shows the top 13 keywords in the field of mass sports management in China. These key words have high frequency. For example, sports management has frequency 249 greater than all other high-frequency words and sports event has low frequency 69 compared to the other 12 words.

According to Figure 6, we can analyze and find that these high-frequency keywords are clustered into eight mainstream knowledge groups, which form the hotspots of research on the management of mass sports in China.

The frequency of "sports management" is much higher than other keywords, indicating that

- (1) The innovative development of public management of sports in China is closely related to effective sports management activities,
- (2) The effective sports management approach, which concentrates and mobilizes all positive factors and forces to facilitate the successful staging of sports events, has important practical reference value for the scientific study of public management of sports in China,
- (3) With the rapid development of China's economy, people's leisure time is gradually increasing, and their awareness of fitness is growing, and sports tourism is becoming one of the most dynamic sunrise industries in China. The number and forms of sports associations have also increased and changed at a faster pace, all of which require that the change in the way sports developed in China should be accelerated. By formulating various guidelines, policies, and regulations, the government is guiding the vigorous development of mass sports in China and providing policy and institutional safeguards to enrich the academic achievements of public management of sports in China.

As its core with "competitive sports", it forms a tightly knit subgroup with China, to reform management system, physical education, talent development, and universities. The National Sports Congress, which began in 2000, is a major reform of China's competitive sports system. In order to meet the needs of the general public for diversified sports, the National Sports Congress has incorporated non-Olympic sports and become a comprehensive domestic sports event alongside the National Games. The tournament is playing an important role in promoting the development of mass sports in China in a wider area, contributing to the general increase in awareness of fitness for all and further expanding its influence and radiating power in society.

With "mass sports" as the core, it forms a subnetwork with "sports culture," "sports organizations," "rural sports," and "traditional ethnic sports." This shows that the promotion, guidance, and education of sporting culture can help people to better understand sporting culture and its rich connotations, so that they can integrate sporting literacy and awareness into their daily lives, improve their overall sporting literacy, and promote the development of the soft power of popular sporting culture.

The high-frequency keywords "sports industry," "sports economy," "stadiums," "management," "development status," and "problems" form a subnetwork. The subnetworks are closely linked to "development status" and "problems." This indicates that the sports industry is a green industry that does not suffer from overcapacity and that some cities are already using it as an important support for their economic development. Currently, cities such as Beijing, Shanghai, and Guangzhou have made the sports industry a sunrise green industry, which has been more effective in promoting GDP growth. Currently, China's government should strengthen the management of sports stadiums by adjusting the business development strategy, implementing diversified business operations, continuing to promote the reform of the management system of stadiums and facilities, and improving the supervision mechanism for the operation of stadiums and facilities, in order to effectively promote the

TABLE 1: High-frequency keywords in the field of sports public management research in China 2000–2021.

Serial number	Keyword	Frequency	Serial number	Keyword	Frequency
1	Sports management	249	8	Sports economy	87
2	Athletics	158	9	Countermeasures	84
3	Mass sports	134	10	School sport	79
4	China	129	11	Management	73
5	Sports industry	112	12	Management system	72
6	Community sports	108	13	Sports events	69
7	Current status	98			

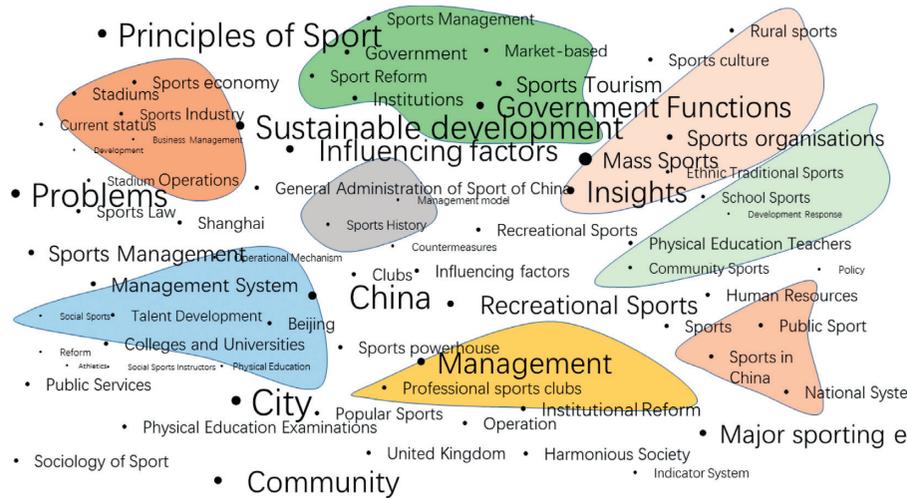


FIGURE 6: Keyword cooccurrence map for research on public management of sport in China.

effectiveness of the management of mass sports in China and ensure the comprehensive implementation of China’s national fitness programmed.

The subgroups are formed by the high-frequency keywords “community sport,” “school sport,” “sustainable development,” “development measures,” “physical education teachers,” and “human resources,” which are closely linked. On the one hand, it can be seen that school sport is the basis for community sport, and community sport is a complement to school sport. By developing the interests of young people in sport, school sport can effectively solve some of the difficulties of community sport (especially family sport), and community sport can also play a role in promoting school sport. Despite the differences between the management systems of community sport and school sport, it is possible to optimize and reform the management systems of school sport and community sport in China to promote their coordinated development. In addition, school sport can be integrated into the urban management and construction system by scientifically deploying the management functions of government departments, so that school sport and community sport are truly integrated, leading to the innovative development of mass sports management. On the other hand, it shows that strengthening the development and management of human resources in China’s sports system, establishing relatively sound rules and regulations for sports human resources management, and

a scientific mechanism for allocating sports human resources are conducive to achieving complementary advantages and sharing resources, promoting the joint development of community sports and school sports, and further promoting the sustainable development of mass sports management in China.

The keywords “sports,” “market economy,” “cities,” “sports activities,” and “sports management system” are closely linked to form subgroups. This shows that as the pace of urbanization in China accelerates, sport and urban development become increasingly close, and sporting activities are a process in which large flows of people, goods, and information from home and abroad converge and are a “link” for cooperation and exchange between cities. The development of urban sports can, on the one hand, attract foreign technology, equipment, manpower, capital, and management experience and, on the other hand, enable some less well-known but high-quality sporting goods (e.g., sports equipment, sportswear, and wearable sports equipment). This will not only help to expand economic cooperation and exchanges between cities, but also strengthen the construction of urban sports facilities and provide more convenient conditions for mass sports activities. This also reflects the value and significance of developing a scientific, effective, and locally appropriate sports management system for the smooth running of mass sports activities.

The high-frequency keywords “fitness for all,” “popular sports,” “management,” “institutional reform,” and

“management” are closely linked to form subgroups. It shows that, with the formulation of the «National Fitness Plan» and the rise of national fitness to a national strategy, more and more people are willing to devote more of their spare time to various sports activities, and the idea of national fitness has become more deeply rooted in the hearts of the people. In the face of this situation, the management system of public sport, which was formed under the previous planned economy, is no longer able to adapt to the changes and needs of the situation, so it is imperative to deepen the reform. On the basis of the public sports products and services provided by the government, enterprises and other social organizations should be invited to invest in public sports to form a strong synergy.

The high-frequency keywords “PSS,” “national system,” “sports power,” “Chinese sports,” “Sports,” and “sports” are closely linked to form subgroups. This indicates that Chinese sport is now in an important historical period of progress from being a large sporting nation to a strong sporting nation, a time of economic development, social progress, and cultural prosperity, but also a period of intensified social transformation and urgent need for deeper institutional reform. The major theoretical, policy, and practical issues in the construction of a strong sporting nation, such as the cultivation of a social sporting culture and citizens’ awareness of sport, public sporting services, innovation in the sport management system, optimization of the structure of competitive sports, cultural education of athletes and training of reserve talents, management and reform of sporting events, and the development orientation and institutional mechanism of professional sports, are all issues that must be taken seriously and addressed in the modernization process of Chinese sport.

## 5. Conclusion

This study takes the literature on public sport services as the investigation object and uses intelligent big data technology to assemble a knowledge map to examine the theoretical development of public sport management in China and to summarize the hot issues of public sport management research and related reasons. Through the expression of the research process and research hotspots of public management of sports in China, it can be seen that the work of public management of sports in China follows closely the national policy direction. While the State encourages the development of mass sports, the management of mass sports by governments, universities, and social organizations at all levels is gradually being carried out in an orderly manner. Moreover, judging from the evolution pattern of past and present research hotspots, there are still many imperfections in the current research on public management of sports, and the aspects of popular sports culture and deepening the supply-side reform of sports may become the development direction of in-depth research in the future. This proposed work is further used in numerous themes to develop the public sport management used at local level, national, and international level.

## Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

## Conflicts of Interest

The author declares that he has no conflicts of interest.

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