# Quantitative Evaluation and Empirical Research of School Sports Strategy Based on PMC Index Model

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**Abstract: Based on the PMC index model, this study constructs a strategy evaluation system covering 10 first-level variables and 40 second-level variables through text mining and combining with the characteristics of school sports development, and makes a quantitative evaluation based on 13 representative school sports strategy texts issued in China during 2014-2024. In order to provide theoretical support and decision-making reference for the development and improvement of school sports strategy in the future. The results show that: (1) the design of 13 sports strategy is generally good, and the average PMC is 7.28, among which 8 are excellent strategy and 5 are acceptable strategy; (2) Based on the analysis of the quantitative evaluation results of each PMC surface and depression, it is concluded that the current school sports strategy has such problems as single time-limited planning, lack of guidance in teaching reform and teacher construction, incomplete strategy content evaluation system, unreasonable strategy implementation and incentive measures, etc., which need to be solved and optimized, and based on this, corresponding strategy optimization suggestions are proposed.**

**Keywords: School Physical Education; Quantitative Evaluation of strategy; PMC Index Model**

## 1. Introduction

On October 15, 2020, the Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era (hereinafter referred to as Opinions) specified the goal of essentially establishing a high-quality school physical education system by 2035[1]. Mao et al. highlighted that "Strengthening school physical education is a crucial means to advance sports education reform"[2], endowing the planning of school sports strategy with new functionalities, clearly delineated tasks, and novel opportunities. Nonetheless, school physical education remains a relatively weak aspect in the quest to build a strong nation in education and sports. Establishing a modernized education system necessitates the refinement and explicit evaluation of contemporary school sports strategy. In recent years, China has successively promulgated multiple school sports strategy documents, which significantly contribute to advancing educational modernization, constructing a healthy China, and implementing talent-driven national development. However, there exist challenges such as suboptimal implementation outcomes of some strategy and execution difficulties, which call for a more profound assessment of the overall effectiveness.

In the quantitative evaluation of school sports strategy, the early methods employed included the Analytic Hierarchy Process (AHP) [3], which evaluates strategy execution based on an established evaluation index system through overall, categorized, and comparative assessments. As methods for quantitative strategy evaluation have continuously evolved and diversified, recent years have witnessed the emergence of various new composite evaluation methods centered on empirical research. These include the CIPP evaluation model [4], decision tree algorithms [5], and rational paradigms related to value rationality and instrumental rationality [6]. However, most of these methods rely on descriptive statistics and theoretical interpretations for classifying school sports strategy, with few comprehensively identifying the strengths, weaknesses, and consistency of the strategy. This has led to common issues such as a narrow research perspective, partial research methods, and subjective design. This study employs the PMC (strategy Modeling

Consistency) Index model proposed by Estrada to comparatively analyze the specific meanings and levels of advantageous and disadvantageous variables in school sports strategy [7]. The PMC model allows for a comprehensive evaluation of strategy by considering the influence of all possible variables, ensuring that no influential factors are overlooked. Through longitudinal comparison, it is found that the PMC index model, compared to existing quantitative evaluation methods for school sports, better incorporates text mining methods in the variable setting process and objectively derives the second-level variables affecting strategy evaluation.

Based on the aforementioned background, and with the construction goal of "Establishing a high-quality school physical education system by 2035", the current timeframe (2024-2035) is divided into strategy periods spanning from 2014 to 2024. A thorough investigation and quantitative analysis of representative school sports strategy documents from the past decade will be conducted. This analysis not only evaluates the extent to which these new-era school sports strategy have been effectively implemented but also serves as a crucial guide from a macro perspective for directing and enhancing the physical health of the youth in the new era.

## 2. Construction of the PMC Index Model

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The PMC (strategy Modeling Consistency) Index model proposed by Estrada offers a means of quantifying and visually representing the internal consistency of a strategy through the PMC index and PMC surface data. This method allows for an in-depth understanding of the overall state of a strategy as well as the specific conditions of individual strategy [8]. The model acquires raw data through strategy text mining and analyzes relevant variables using a knowledge graph map. This approach significantly mitigates the partiality and subjectivity in result analysis, making it one of the most advanced strategy analysis methods available today. The model includes four key steps: variable classification and parameter identification, the construction of multi-regional input-output tables, calculation of the PMC index, and the plotting of PMC surfaces. The process of constructing the PMC Index model for school sports strategy over the past decade in this paper includes the following steps (as illustrated in Figure 1): First, through the organization and analysis of strategy texts and relevant literature, the core structure and scope of school sports strategy are presented using the ROSTCM 6.0 word frequency analysis tool. This step helps in defining the variables for the PMC index model. Second, a multi-regional input-output table for school sports strategy is constructed. Binary values are assigned to each variable, with a value of 1 given when the evaluated strategy aligns with the second-level variable, and 0 assigned otherwise. Finally, an in-depth analysis and evaluation of the school sports strategy are carried out through the calculation of the PMC index and the plotting of PMC surface charts.

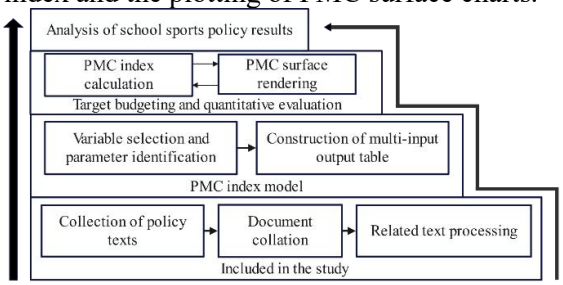


**Figure 1. Construction Process of the PMC Index Model**

### 2.1 Variable Classification and Parameter Identification

In this study, the ROSTCM6 word frequency analysis tool is employed to merge and segment strategy texts, extracting high-frequency words and features related to school sports strategy. Common and insignificant words, which do not contribute meaningfully to the study, are filtered out. Consequently, the top 50 high-frequency thematic words and the social network knowledge graph are identified (see Table 1 and Figure 2). The text mining results show that the top five terms are "physical education", "school", "student", "education", and "teaching". The co-occurrence relationships among key terms indicate that "school", "education", and "teaching" are highly interconnected with other

keywords, underscoring the centrality of schools in sports strategy, impacting students' physical health, teacher professional development, facility improvements, and management mechanisms. Education and teaching form the strategy's foundation, influencing areas such as the education system's enhancement, deepening of curriculum reform, and the establishment of physical health standards.

To enhance the specificity and timeliness of the evaluation of school sports strategy, this study is based on Ruiz's quantitative strategy evaluation method. Referencing the classification variable settings of the PMC index model by scholars such as Hu et al. [9], Cheng et al. [10], and Wang et al. [11], and considering the distribution of high-frequency keywords in the social network knowledge graph and the unique characteristics of the strategy texts, a comprehensive quantitative PMC index model for school sports strategy has been constructed (see Table 2). This model comprises 10 first-level variables and 40 second-level variables. Within this framework, strategy attributes (X1), Sustained Effectiveness (X2), issuing authority (X3), strategy evaluation (X9), and document citation (X10) primarily assess the quality of strategy from the perspective of fundamental features. In contrast, content relevance (X4), target participants (X5), strategy function (X6), objective orientation (X7), and incentive measures (X8) evaluate the response efficacy of the strategy across five dimensions: domain coverage, target audience, effectiveness, problem resolution, and implementation assurance.

**Table 1. Distribution of High-Frequency Thematic Words in School Sports strategy**

| No. | Word | Frequency | No. | Word | Frequency |
|---|---|---|---|---|---|
| 1 | Physical education | 886 | 26 | Physical fitness | 154 |
| 2 | School | 752 | 27 | System | 151 |
| 3 | Student | 559 | 28 | Develop | 147 |
| 4 | Education | 428 | 29 | National | 146 |
| 5 | Teaching | 272 | 30 | Promote | 139 |
| 6 | Strengthen | 264 | 31 | Sports venues | 138 |
| 7 | Health | 260 | 32 | Improve | 129 |
| 8 | Reform | 257 | 33 | Guarantee | 125 |
| 9 | Development | 253 | 34 | Level | 124 |
| 10 | Mechanism | 243 | 35 | Comprehensive | 121 |
| 11 | Teacher | 238 | 36 | Safety | 118 |
| 12 | System | 236 | 37 | Local | 118 |
| 13 | Open | 224 | 38 | Adhere | 116 |
| 14 | Improve | 223 | 39 | Curriculum | 116 |
| 15 | Society | 217 | 40 | Institution | 111 |
| 16 | Evaluation | 210 | 41 | Government | 111 |
| 17 | Establish | 198 | 42 | Exercise | 110 |
| 18 | Construction | 195 | 43 | Culture | 109 |
| 19 | Management | 193 | 44 | Implement | 103 |
| 20 | Standard | 186 | 45 | Cultivate | 101 |
| 21 | Department | 183 | 46 | Promote | 98 |
| 22 | Service | 175 | 47 | Facility | 97 |
| 23 | Training | 172 | 48 | Quality | 96 |
| 24 | Organization | 168 | 49 | Encourage | 95 |
| 25 | Soundness | 166 | 50 | System | 94 |

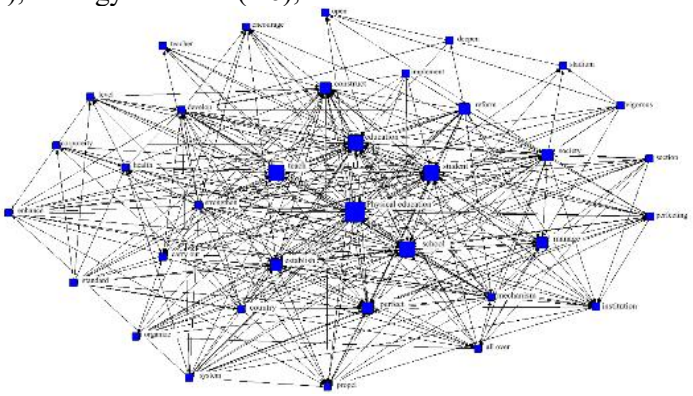

**Figure 2. Social Knowledge Graph of School Sports strategy**

**Table 2. Variable Settings for the Quantitative Evaluation of School Sports strategy over the Past Decade Based on the PMC Index Model**

| | | |
|---|---|---|
| X1 strategy Nature | X1-1: Predictive, X1-2: Advisory, X1-3: Regulatory, X1-4: Descriptive, X1-5: Directive | Hu et al. [9] |
| X2 Sustained Effectiveness | X2-1: Short-term, X2-2: Medium-term, X2-3: Long-term | Cheng et al. [10] |
| X3 Issuing Authority | X3-1: National, X3-2: General Administration of Sport, X3-3: Various Ministries | Wang et al. [11] |
| X4 Content Relevance | X4-1: Student physical fitness monitoring, X4-2: Curriculum reform, X4-3: Professional teacher development, X4-4: Facility improvement, X4-5: Enhanced management mechanisms, X4-6: Risk management in sports, X4-7: Sports | Social Network Knowledge Graph |

| | | |
|---|---|---|
| | facility openness, X4-8: After-school sports services | |
| X5 Target Participants | X5-1: Schools, X5-2: Government, X5-3: Community, X5-4: Institutions | Social Network Knowledge Graph |
| X6 strategy Function | X6-1: Clear responsibilities, X6-2: Normative guidance, X6-3: Coordinated management, X6-4: Categorized promotion | Social Network Knowledge Graph |
| X7 Objective Orientation | X7-1: Strengthen organizational management, X7-2: Improve the education system, X7-3: Enhance teacher competency, X7-4: Develop robust education standards, X7-5: Establish health fitness standards | Social Network Knowledge Graph |
| X8 Incentive Measures | X8-1: Talent incentives, X8-2: Financial subsidies, X8-3: Legal regulations, X8-4: Others | Li et al. [12] |
| X9 strategy Evaluation | X9-1: Clear objectives, X9-2: Sufficient basis, X9-3: Delineated responsibilities, X9-4: Scientific schemes | Zhu [13] |
| X10 Document Citation | None | Ruiz Estrada [7] |

### 2.2 Stablishment of the Multi-Regional Input-Output Table

The multi-regional input-output table is a data analysis framework that can store vast amounts of data and evaluate individual strategy indicators through single variables measured across multiple dimensions. This allows it to reflect the evolution of a given strategy [14]. In the table, the first-level variables consist of multiple second-level variables, and the number of second-level variables is not restricted. In simple terms, the multi-regional input-output table does not have a fixed hierarchical structure. Instead, it categorizes the variables based on the second-level variables, with each variable carrying equal weight and independence. This study constructs a multi-regional input-output table that fully embodies the flexibility of multi-dimensional data analysis to reflect various indicators of school sports strategy (see Table 3).

**Table 3. Multi-Regional Input-Output Table**

| First-level Variables | Second-level Variables | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | P13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X1 | X1-1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| | X1-2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X1-3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X1-4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X1-5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| X2 | X2-1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | X2-2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | X2-3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| X3 | X3-1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| | X3-2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| | X3-3 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| X4 | X4-1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| | X4-2 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| | X4-3 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| | X4-4 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| | X4-5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X4-6 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X4-7 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| | X4-8 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| X5 | X5-1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X5-2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X5-3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X5-4 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| X6 | X6-1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X6-2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X6-3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X6-4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| X7 | X7-1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X7-2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X7-3 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X7-4 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X7-5 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| X8 | X8-1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X8-2 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| | X8-3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X8-4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| X9 | X9-1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X9-2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X9-3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | X9-4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| X10 | | | | | | | | | | | | | | |

| | |
|---|---|
| 7.00 - 8.99 | Excellent |
| 9.00 - 10.00 | Perfect |

### 2.3 Calculation of the PMC Index

According to Estrada's calculation method, the first step involves inputting each level of variables from the school sports strategy evaluation system into the multi-regional input-output table. The second-level variables in the strategy evaluation system are then assigned values based on formulas (1) and (2), which are valued at 1 if the relevant strategy text includes the variable content, and 0 otherwise.

$$X \sim N\,[0,1] \quad (1)$$

$$X=\{XR:\,[0\sim 1]\} \quad (2)$$

Next, first-level variables within the strategy evaluation system are calculated using formula (3), where t represents the first-level variable, j denotes the second-level variable, and n is the number of second-level variables under a given first-level variable, ranging from 1 to 9.

$$X_t = \left(\sum_{j=1}^{n} \frac{X_{tj}}{N(X_{tj})}\right), t = 1,2, \quad (3)$$

Subsequently, the PMC index value for the strategy under evaluation is determined by formula (4), which sums the parameters of all first-level variables.

$$PMC = X_1\left(\sum_{a=1}^{5}\frac{X_{1i}}{5}\right) + X_2\left(\sum_{b=1}^{3}\frac{X_{2j}}{3}\right) + X_3\left(\sum_{c=1}^{3}\frac{X_{3k}}{3}\right) + X_4\left(\sum_{d=1}^{8}\frac{X_{4l}}{8}\right) + X_5\left(\sum_{e=1}^{4}\frac{X_{5m}}{4}\right) + X_6\left(\sum_{f=1}^{4}\frac{X_{6n}}{4}\right) + X_7\left(\sum_{g=1}^{5}\frac{X_{7o}}{5}\right) + X_8\left(\sum_{h=1}^{4}\frac{X_{8p}}{4}\right) + X_9\left(\sum_{i=1}^{4}\frac{X_{9q}}{4}\right) + X_{10} \quad (4)$$

Finally, by calculating the PMC index, the level of strategy consistency can be evaluated. According to Estrada's evaluation standards, strategy can be categorized into four grades: Poor, Acceptable, Excellent, and Perfect (see Table 4).

**Table 4. Strategy Grading Standards**

| PMC Index Score | Grade |
|---|---|
| 0 - 4.99 | Poor |
| 5.00 - 6.99 | Acceptable |

### 2.4 Construction of the PMC Surface

To provide a more intuitive reflection of the overall status of school sports strategy, as well as the relative merits and demerits among various strategy [15], a PMC surface is constructed. Given that X10 consists only of first-level variables and considering the symmetry and surface balance of the PMC matrix, a third-order strategy PMC surface for evaluating school sports strategy is structured according to formula (5). This foundation will be used to analyze the deficiencies of each strategy.

$$PMC = \begin{bmatrix} X_1 & X_2 & X_3 \\ X_4 & X_5 & X_6 \\ X_7 & X_8 & X_9 \end{bmatrix} \quad (5)$$

## 3 Empirical Analysis

### 3.1 Selection of Strategy Samples

Considering the practical challenges in the development of school physical education, as well as the timeliness and specificity of strategy implementation, and to ensure the accessibility, relevance, comprehensiveness, and comparability of strategy texts, this study selects effective strategy issued at the national level over the past decade. The inclusion period for these strategy is set from January 2014 to January 2024. By accessing relevant websites such as the Chinese government portal, the General Administration of Sport of China, the Ministry of Education, and www.pkulaw.cn, a total of 13 school sports strategy documents issued at the national level have been collected and summarized (see Table 5).

**Table 5. List of School Sports Strategy from 2014 to 2024**

| No. | Strategy Name | Date of Issue |
|---|---|---|
| P1 | National Student Physical Health Standards (2014 Revision) | July 8, 2014 |
| P2 | Interim Measures for the Prevention and Control of School Sports Risks | April 30, 2015 |
| P3 | Opinions on Strengthening School Physical Education to Promote Comprehensive Physical and Mental Health Development of Students | May 6, 2016 |
| P4 | Implementation Opinions on Promoting the Opening of School Sports Venues to the Public | February 3, 2017 |
| P5 | Opinions on Deepening Educational and Teaching Reform to Improve the Quality of Compulsory | June 23, 2019 |

| | | |
|---|---|---|
| | Education Comprehensively | |
| P6 | Opinions on Deepening the Integration of Sports and Education to Promote the Healthy Development of Adolescents | August 31, 2020 |
| P7 | Overall Plan for Deepening Reform of Education Evaluation in the New Era | October 13, 2020 |
| P8 | Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era | October 15, 2020 |
| P9 | Notice on Further Strengthening the Physical Health Management of Primary and Secondary School Students | April 19, 2021 |
| P10 | Guideline for the Reform of (Sports and Health) Teaching (Trial) | June 23, 2021 |
| P11 | Notice on Improving the Level of After-School Sports Services to Promote Healthy Growth of Primary and Secondary School Students | June 14, 2022 |
| P12 | Opinions on Regulating Non-Academic Extracurricular Training for Primary and Secondary School Students | November 30, 2022 |
| P13 | Notice on Doing a Good Job in School Physical Education Under the Current Epidemic Situation | February 14, 2023 |

### 3.2 Strategy Model Analysis

The classification of different strategy levels based on their PMC index values clearly reveals the varying levels of implementation intensity and market response to school sports strategy. Generally, strategy with high PMC indices tend to have clear implementation goals, adequate resource support, and diverse participation. In contrast, strategy with lower PMC indices might face challenges such as limited resources and high difficulty in execution. Analyzing the classification of each strategy according to its index value, it is found that over the past decade, school sports strategy are mainly divided into two levels: Excellent and Acceptable. Among them, there are 8 strategy in the Excellent level and 5 strategy in the Acceptable level (Table 6). From the results above, the PMC indices of various strategy range from 6.34 to 8. P11, Notice on Improving the Level of After-School Sports Services to Promote Healthy Growth of Primary and Secondary School Students, has the highest PMC index score of 8, indicating that this strategy performs excellently in execution, with clear goals, a strong response to the practical issues in school physical education, and significant achievements in enhancing after-school sports services. Conversely, P1, National Student Physical Health Standards (2014 Revision), has the lowest PMC index score of 6.34, suggesting that the strategy has a lower responsiveness and might face constraints in facilities and resources during the promotion of new standards within the school system. Similarly, P2, Interim Measures for the Prevention and Control of School Sports Risks, and P9, Notice on Further Strengthening the Physical Health Management of Primary and Secondary School Students, have PMC indices of 6.97 and 6.84 respectively. These results indicate that while these strategy show some level of effectiveness, there is still considerable room for improvement. Given the crucial role of students' physical health and sport risk management in school sports activities, it is imperative to formulate detailed and practical emergency measures within the school education system. Furthermore, P7, Overall Plan for Deepening Reform of Education Evaluation in the New Era, and P13, Notice on Doing a Good Job in School Physical Education Under the Current Epidemic Situation, also fall under the Acceptable level, with scores of 6.92 and 6.79. This suggests that, with changes in the educational and sports environment, the challenges and uncertainties faced by strategy implementation are high, leading to a lower responsiveness of these strategy. strategy P3-6, P8, and P10-12 are classified as Excellent, with higher PMC index scores. This demonstrates the high efficiency in the design and implementation of these strategy, achieving substantial progress in promoting the integration of sports and education, the sharing of school sports facilities, and teaching reforms.

**Table 6. Measurement of PMC Index for School Sports Strategy**

| Evaluation Index | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | P13 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X1 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 0.80 | 1.00 | 1.00 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 |
| X2 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 |
| X3 | 0.33 | 0.33 | 0.33 | 0.67 | 0.33 | 0.67 | 0.33 | 0.33 | 0.33 | 0.33 | 0.67 | 0.67 | 0.33 | 0.44 |
| X4 | 0.38 | 0.75 | 1.00 | 0.63 | 0.75 | 1.00 | 0.50 | 1.00 | 0.63 | 1.00 | 1.00 | 0.75 | 0.63 | 0.77 |
| X5 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.75 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.98 |
| X6 | 0.75 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.98 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X7 | 1.00 | 0.80 | 1.00 | 0.40 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.94 |
| X8 | 0.75 | 0.75 | 1.00 | 1.00 | 1.00 | 0.75 | 1.00 | 1.00 | 0.75 | 1.00 | 1.00 | 1.00 | 0.50 | 0.88 |
| X9 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| PMC Index | 6.34 | 6.97 | 7.67 | 7.03 | 7.42 | 7.55 | 6.92 | 7.67 | 6.84 | 7.67 | 8.00 | 7.75 | 6.79 | 7.28 |
| strategy Rating | Acceptable | Acceptable | Excellent | Excellent | Excellent | Excellent | Acceptable | Excellent | Acceptable | Excellent | Excellent | Excellent | Acceptable | |

### 3.3 PMC Curve Analysis

The PMC surface provides a more intuitive display of the quantitative evaluation results of school sports strategy. If the depressions in the PMC surface are deeper, it indicates lower scores for the strategy-related variables, reflecting deficiencies in the strategy. Conversely, if the PMC surface is closer to the top of the matrix graph, it indicates higher scores for the strategy-related variables, reflecting a comparative advantage of the strategy. The smoothness of the surface reflects the coherence of the strategy. Therefore, this study utilizes the first-level variable values of the PMC index model to construct a three-dimensional PMC surface diagram (Figures. 3-14), presenting the degree of depressions, strengths, and limitations of various school sports strategy from multiple dimensions. Additionally, we analyze the specific optimization paths of strategy in conjunction with multi-regional input-output tables. Given that the strategy rating in this PMC index measurement scenario only includes two levels—"Excellent" and "Acceptable"—for easier understanding and analysis, the two evaluation standards are named "Level I" (Excellent) and "Level II" (Acceptable), respectively.

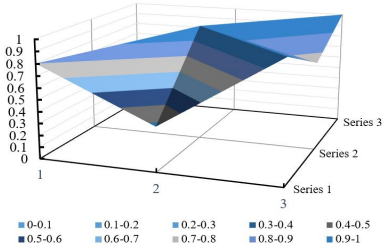


**Figure 3. Surface Chart of School Sports Strategy P1**

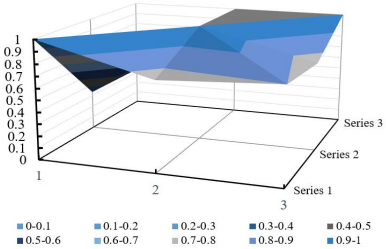


**Figure 4. Surface Chart of School Sports Strategy P2**

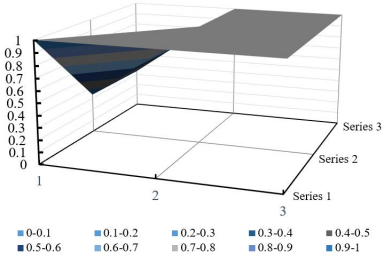


**Figure 5. Surface Chart of School Sports Strategy P3**

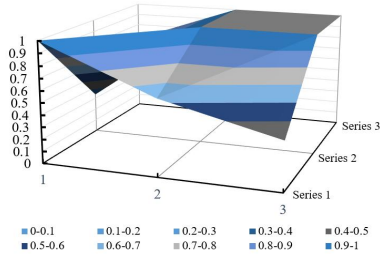


**Figure 6. Surface Chart of School Sports strategy P4**

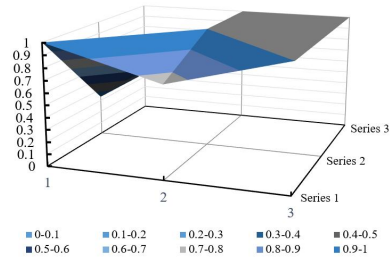


**Figure 7. Surface Chart of School Sports Strategy P5**

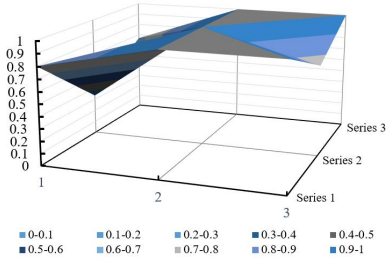


**Figure 8. Surface Chart of School Sports Strategy P6**

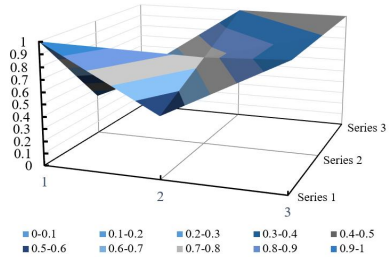


**Figure 9. Surface Chart of School Sports Strategy P7**

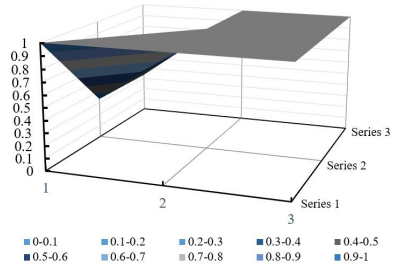


**Figure 10. Surface Chart of School Sports Strategy P8, P10**

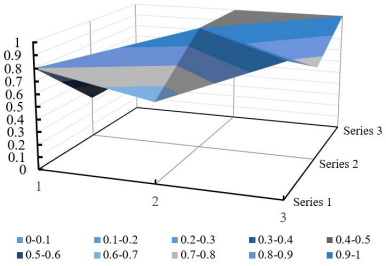


**Figure 11. Surface Chart of School Sports Strategy P9**

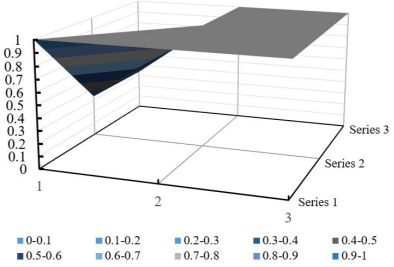


**Figure 12. Surface Chart of School Sports Strategy P11**

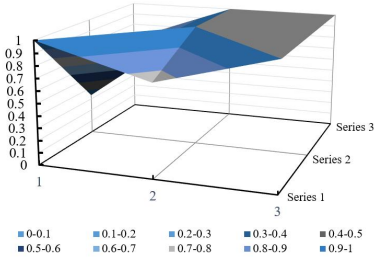


**Figure 13. Surface Chart of School Sports Strategy P12**

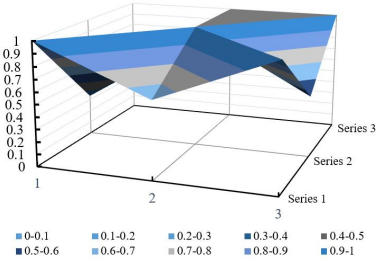


**Figure 14. Surface Chart of School Sports Strategy P12**

3.3.1 Holistic analysis of PMC evaluation indicators

Since the reform and opening up, school physical education in China stands at a crucial juncture in the development of contemporary sports education. The formulation and research of school sports strategy should focus on serving the development of school sports, meeting the comprehensive physical and mental health needs of youth in this era. Reviewing the development of school sports strategy, it is evident that strategy P1—P13 are characterized by diversity and comprehensiveness. Modern school sports strategy should respond to the requirements of the times, highlight educational values, improve top-level design, and encourage a multi-faceted execution system involving society, schools, and families [16]. Therefore, a multidimensional holistic evaluation of school sports strategy is a necessary precondition for strategy formulation and implementation. It is an important guideline for the development and optimization of school sports in China and holds significant practical relevance. As shown in Table 4, by averaging the first-level variable values of the 13 school sports strategy, we can assess their overall performance. Among them, the averages of X2 and X3 are 0.33 and 0.44, respectively, whereas X9 has an average of 1.00. According to Figure 15, firstly, the indicators for Sustained Effectiveness (X2) and Issuing Authority (X3) are relatively low. This is due to the fact that most school sports strategy are effective for a long term and that several strategy are issued by various national ministries and commissions rather than being led legislatively by the General Administration of Sport of China. Secondly, the strategy Evaluation (X9) indicator is the highest, indicating that the specific performances of the various school sports strategy meet the criteria of clear objectives, sufficient basis, delineated responsibilities, and scientific schemes.

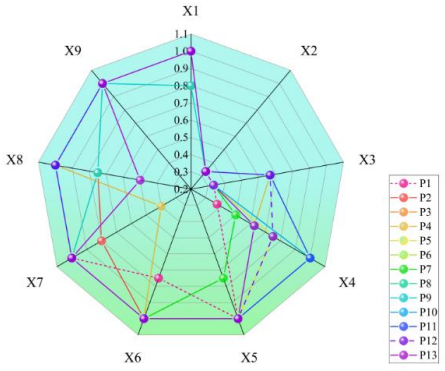


**Figure 15. Radar Chart of the Holistic Performance of PMC Evaluation Indicators**

3.3.2 Analysis of tier I school sports strategy

School physical education in China has embarked on a new development phase, characterized by increasingly detailed, scientific, systematic, and clear strategy frameworks formulated by various departments. According to the radar chart of the overall performance of PMC evaluation indicators, the assessment ranks of Tier I school sports strategy are as follows: P11 > P12 > P10 > P8 > P3 > P6 > P5 > P4. From the PMC surface charts of these eight strategy (Figures. 5-8, 10, 12, 13), it is evident that with the exception of P4, their depression levels exceed the average value (7.28). Comparatively, an ideal strategy model (X1—X9=1) reveals that P11 achieves a perfect strategy rating in all indicators at 1.00 except Sustained Effectiveness (X2) and Issuing Authority (X3).

Specifically, the weaknesses of the Implementation Opinions on Opening School Sports Facilities to Society (P4) are mainly concentrated in areas such as Sustained Effectiveness (X2 at 0.33), Issuing Authority (X3 at 0.67), Content Relevance (X4 at 0.63), and Objective Orientation (X7 at 0.40). Figure 6 highlights that the primary issues with strategy P4 lie in the breadth of content involved and the clarity of objective orientation, both requiring further enhancement. The strategy P4 generally aims to deepen school sports reform, promote extracurricular exercise for students, and open school sports facilities to the public to meet the growing demand for fitness. However, the implementation process urgently needs to specify clear standards and targets to ensure the effectiveness and anticipated results of strategy P4. Additionally, the depression levels of strategy P11, P12, P10, P8, P3, P6, and P5 are generally weak in the Sustained Effectiveness (X2 at 0.33), with most strategy (except P10) being long-term oriented, yet lacking articulated short-term and mid-term execution plans and measures.

The three best-performing strategy among Tier I school sports strategy are the Notice on Improving the Level of After-School Sports Services to Promote Healthy Growth of Primary and Secondary School Students, the Opinions on Regulating Non-Academic Extracurricular Training for Primary and Secondary School Students, and the Guideline for the Reform of (Sports and Health) Teaching (Trial) (P10). These three strategy exhibit excellent commonalities in various aspects, including the nature of the strategy, involved participants, strategy functions, objective orientation, and strategy evaluation. Firstly, all three strategy aim to consistently focus on and enhance the physical health and educational training of primary and secondary school students, guiding schools to sufficiently incorporate physical education into the curriculum to ensure ample exercise time for students. Secondly, strategy P11 and P12 emphasize synergistic actions by integrating diverse resources and expertise, thereby enriching the content of after-school sports services to provide students with more high-quality opportunities for sports learning and exercise. strategy P11 and P10 further excel in Objective Orientation and evaluation by emphasizing student health as the core, reinforcing the primary responsibilities of educational administrative departments and schools, and promoting the implementation of sports education reform and the improvement of teaching quality. In conclusion, the strengths of strategy P11, P12, and P10 stem from their scientific design, comprehensive attention to school physical education, and strong emphasis on the physical and mental health and holistic development of primary and secondary school students.

3.3.3 Analysis of tier II school sports strategy

The evaluation ranks for Tier II school sports strategy are as follows: P2 > P7 > P9 > P13 > P1, as illustrated in Figure 4. The Interim Measures for the Prevention and Control of School Sports Risks (P2) exhibits the least depression, scoring a perfect 1.00 in strategy Attributes (X1), Target Participants (X5), strategy Function (X6), and strategy Evaluation (X9). On a macro level, strategy P2 mandates that educational administrative departments and schools must not reduce physical activities to avoid sports risks, while clearly defining the participants and nature of the strategy. It emphasizes the function of educational authorities and schools to establish and improve mechanisms for preventing and controlling school sports risks, aiming to prevent and avoid sports-related injuries. However, the strategy shows significant weaknesses in Sustained Effectiveness (X2) and Issuing Authority (X3). To better protect

the legal rights of students, teachers, and schools and to ensure the healthy and orderly development of school physical education, strategy P2 needs further enhancement in these areas.

The National Student Physical Health Standards (2014 Revision) (P1) exhibits several shortcomings across various indicators, such as weak sustained effectiveness, relatively singular content, and insufficient incentive measures. Although strategy P1 specifies clear standards and requirements for evaluating and measuring student physical fitness and health, it lacks long-term implementation and continuous improvement plans. Content-wise, strategy P1 primarily focuses on testing and assessment, lacking innovation in incentive measures, feedback adjustments, and educational guidance. The existing reward measures reflected in the content are insufficiently robust, necessitating more innovation and expansion to motivate students to actively engage in physical exercise.

## 4. Conclusion and Recommendations

### 4.1 Conclusion

This study employs the PMC index model and data from ROSTCM6 software, coupled with the social knowledge graph of school sports strategy, to create a quantitative evaluation system encompassing 10 first-level and 40 second-level variables. Using this system, 13 school sports strategy are evaluated. The findings indicate that the strategy P1—P13 are characterized by diversification and comprehensiveness, with an average PMC score of 7.28. These strategy generally align with the standards of having "clear objectives, sufficient basis, delineated responsibilities, and scientific schemes" as per the X9 indicator. Out of these, there are eight Tier I and five Tier II strategy. Notably, the evaluation revealed lower scores for the Sustained Effectiveness (X2) and Issuing Authority (X3) indicators, indicating areas needing improvement. Specific strategy areas requiring enhancement include strategy Attributes (X1), Content Relevance (X4), and Incentive Measures (X8). Based on the assessment of the PMC profiles and the degree of strategy depression, targeted recommendations are provided across six key aspects: strategy characteristics, involved fields, participant coverage, effectiveness, issue resolution, and implementation guarantees.

(1) strategy Characteristics: All strategy exhibit properties such as "recommendation, regulation, description, and guidance". They collectively demonstrate strengths, such as having clear objectives, sufficient basis, delineated responsibilities, and scientific schemes. Nonetheless, they primarily establish long-term and comprehensive mechanisms, often lacking short-term or medium-term goals and action plans. There is a particular shortfall in addressing urgent or localized issues with specific short-term or medium-term strategies.

(2) Involved Fields: The majority of strategy focus on the management system of school sports and sports-related risks. However, they are relatively weak in areas like teaching reform, teacher development, and sports facility construction. Especially between 2014 and 2019, insufficient emphasis was placed on curriculum teaching reform and physical education teacher development. Going forward, school sports strategy should prioritize improving teacher capabilities through curriculum reforms.

(3) Participant Coverage: Most strategy comprehensively include schools, governments, and communities as participants, ensuring broad strategy coverage. Particularly significant is the role of training institutions. The 2020 Opinions encouraged certain regions to collaborate with specialized institutions to offer sports education services to primary and secondary schools, addressing the issue of insufficient physical education teachers. This measure has significantly invigorated the school sports atmosphere and promoted after-school sports activities.

(4) Effectiveness: The overall effectiveness indicators of school sports strategy are commendable. However, the actual execution of these strategy, in terms of clarity of (5) Issue Resolution and Implementation Guarantee: Certain strategy fall short in areas such as "ensuring talent incentives and enhancing teacher quality" and "securing financial subsidies and setting fitness health standards". Specifically, teacher development and curriculum reform strategy lack detailed implementation guarantees and guidelines. Moreover, the current state of strategy execution, student fitness levels, and school sports resources needs urgent improvement.

### 4.2 Recommendations

Based on the quantitative analysis of strategy evaluation, it has been found that, over the past decade, China's school sports strategy primarily fall into two categories: excellent and acceptable. Among these, eight strategy are rated as excellent, while five are considered acceptable. The overall quality of these strategy is commendable; however, no strategy has achieved a perfect rating. Furthermore, the gap between the highest and lowest scores in the first-level variable indicators is substantial, with different strategy exhibiting varying weaknesses. To address these challenges and promote the optimized development of school sports strategy, the following recommendations are presented, aiming to offer a high-level theoretical framework to guide the high-quality development of school physical education.

(1) A Focus on Timeliness through a Combination of Long-Term, Medium-Term, and Short-Term Planning: The majority of school sports strategy in China currently focus on long-term, holistic approaches, with insufficient attention given to medium-term and short-term planning and implementation. As new issues continuously arise within the changing educational and sporting environments, there is often a pressing need for timely solutions. However, due to the vagueness and delayed nature of strategy issuance, existing issues have not benefited from advanced theoretical guidance, thus hindering further development and refinement of school physical education. A potential solution may lie in the establishment of a public data statistics bureau to assess the effectiveness of strategy implementation and public satisfaction. Strengthening interdepartmental cooperation, alongside encouraging the regulatory involvement of various stakeholders, could help empower community oversight. By creating performance assessment standards and adopting a rewards-and-penalties system, provinces and cities may be encouraged to leverage local resources, align with national strategies, and develop a cohesive combination of long-term, medium-term, and short-term school sports strategy. For example, short-term strategy might address immediate issues with urgency and precision, while medium-term strategy could focus on the upgrading and expansion of sports facilities, promoting continuous regional development. Long-term strategy could then focus on systemic reforms in education and curriculum. This integrated approach could provide effective guidance at various stages of school physical education development.

(2) A Focus on Demand, Refining Practical Guidance for Teaching Reform and Teacher Development: While enhancing students' physical fitness and mitigating sports risks hold significant importance, there remains a relative weakness in practical guidance related to teaching reforms, teacher development, and the development of sports facilities. Future strategy could benefit from more detailed goal-setting, with careful consideration of local differences in teacher expertise and student needs. Establishing regional standards for teacher recognition and professional advancement might mitigate the influence of resource-rich regions on remote areas, thus ensuring that physical education teachers are more motivated and engaged in their profession. Furthermore, a more refined approach to curriculum reform could be made by examining five key dimensions: philosophy, objectives, content, implementation, and evaluation. The reform should ideally aim to foster greater student engagement and physical well-being by promoting a balanced curriculum that merges traditional and modern sports activities, with an added focus on healthy living. Incorporating digital tools and online platforms may also support self-directed student training and skill development.

(3) Balancing Effectiveness through a Multidimensional strategy Evaluation System: The establishment of a comprehensive school physical education system requires the involvement of numerous sectors, necessitating coordination and oversight across different departments. To prevent inefficiencies and the passing of responsibility among organizations, it would be crucial to clearly delineate the roles and responsibilities of each involved entity, ensuring a transparent and well-coordinated working environment. A potential solution might involve the creation of a collaborative strategy evaluation team, including representatives from the Ministry of Education, the General Administration of Sport, schools, and parent committees. This team could conduct regular field inspections

and employ quantitative methods such as surveys and interviews to assess the effectiveness of strategy implementation. By analyzing the data and results, a deeper understanding of the challenges and constraints faced during strategy execution may emerge, enabling targeted revisions and improvements.

(4). Establishing Safeguards and Enhancing Incentive Mechanisms for strategy Implementation: At present, areas such as teacher development and curriculum reform within China's school sports strategy lack clear implementation safeguards and detailed guidelines. Future strategy could be enhanced by clarifying provisions related to funding, teacher training, and talent incentives. Achieving a balanced use of various strategy instruments might improve the overall impact and guidance of strategy implementation. Moreover, strategy could include specific regulations concerning student physical fitness standards, after-school sports services, facility construction, sports venue development and operation, student activity risk management, and supervision. Such comprehensive regulatory frameworks would ensure a more standardized approach across all entities involved in the school physical education system.

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