International Journal of Sociologies and Anthropologies Science Reviews
Volume 5 Issue 2: March-April 2025: ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index

Development of Evaluation Model for 3X3 Basketball Referee Performance in the People's Republic of China

Zhou Yang[1], Chanchai Siriphan[2] and Wisute Tongdecharoen[3]
[1,2,3]Faculty of Sports Science and Technology, Bangkokthonburi University, Thailand
[1]E-mail: 2383305@163.com, ORCID ID: https://orcid.org/0009-0008-0489-743X
[2]E-mail: siriphan.cs@gmail.com, ORCID ID: https://orcid.org/0009-0000-9981-655X
[3]E-mail: wisute.ton@bkkthon.ac.th, ORCID ID: https://orcid.org/0009-0008-5233-7533

Received 14/09/2024 Revised 18/09/2024 Accepted 18/10/2024

Abstract

Background and Aim: The proficiency of basketball referees' judgment not only directly impacts the technical and tactical aspects of the sport but also significantly influences the development of good sportsmanship within teams. Consequently, basketball referees play a crucial role in promoting the advancement of modern basketball, aiming for higher standards in terms of speed, accuracy, and overall health. Therefore, this research aims to develop an evaluation model for 3X3 basketball referee performance in the People's Republic of China.

Materials and Methods: This study is a mixed-methods research. The participants of this study can be divided into the following four groups: (1) 288 referees from Chinese basketball were selected to participate in the questionnaire; (2) 7 experts were invited for in-depth interviews; (3) 19 experts were invited to participate in two rounds of Delphi studies; and (4) 9 experts were invited to discuss and confirm the evaluation index model for the officiating performance of Chinese three-on-three basketball referees. The data obtained from the questionnaire was analyzed using mean and standard deviation, while consensus data was analyzed using median and CV, with the set standard being median ≥ 3.50 and CV ≤ 0.25.

Results: The evaluation index model for the officiating performance of Chinese three-on-three basketball referees consists of 2 first-level indicators from theoretical classification, which are: (A) Assessment and evaluation scores; (B) Training and recommendation scores, and also includes 5 second-level indicators and 19 third-level indicators.

Conclusion: After expert discussion by the connoisseurship method, the evaluation model for 3X3 basketball referee performance was confirmed, and all indicators in the developed evaluation model can be preserved.

Keywords: Evaluation Indicator Model; 3x3 Basketball; Referee; Refereeing Performance

Introduction

The professionalization of referees' management is currently a focal and challenging aspect of China's professional sports reform, attracting widespread social attention. The Chinese Basketball Association (CBA) serves as a symbol of basketball development in China. Its professional operation not only carries the responsibility of elevating the level of competitive basketball in China but also focuses on nurturing reserve talents for the sport. Basketball was one of the earliest sports in China to undergo professionalization reforms, and in recent years, the social influence of basketball leagues has been increasingly expanding. Therefore, the professionalization reform for referees in basketball matches is essential (Sun, 2019).

In the era of new media, the details of every referee's calls in basketball matches are exposed to the public, subjecting them to the pressures of public opinion. This has compelled referees to improve their officiating abilities. Consequently, establishing a comprehensive set of evaluation indicators for referees' officiating skills can contribute to advancing the professionalization process. Over the past twenty years of development in the CBA, most referees in the league were non-professionals. During the 2019-2020 season of the CBA league, professional referees were introduced. This move has positive implications for enhancing the technical and tactical levels of the CBA league, developing the commercial value of the league, improving the league's system, and allowing Chinese basketball to integrate better and faster onto the world stage.

In addition to ensuring the smooth progress of matches and maintaining a fair and just competitive environment, referees also bear the responsibility of guiding and elevating the technical levels of teams, exerting direct or indirect influences on the direction and levels of basketball development. In the context of professionalizing basketball referees, the training and management of grassroots referees should be

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standardized and professionalized to prepare a reserve talent pool for the referee team and contribute to the development of Chinese basketball.

The proficiency of basketball referees' judgment not only directly impacts the technical and tactical aspects of the sport but also significantly influences the development of good sportsmanship within teams. Consequently, basketball referees play a crucial role in promoting the advancement of modern basketball, aiming for higher standards in terms of speed, accuracy, and overall health. Basketball consists of three fundamental elements: players, coaches, and referees. As modern basketball has rapidly developed, individual skills have become more refined, physical confrontations have intensified, and team tactics have grown more diverse. Consequently, these changes have raised the bar for the officiating abilities of basketball referees. Despite continuous modifications and improvements to basketball rules and the efforts made by basketball associations in referee training, there remains a gap between the proficiency of referees and players. To steadily advance the development of modern basketball and better serve high-level athletes, it is imperative to establish referee evaluation criteria that cater to the varying levels of competition (Zhang and Li, 2016).

Research Objectives

Main Objective

To develop an evaluation model for 3X3 basketball referee performance in the People's Republic of China

Subsidiary Objectives

1. To study the current situation and problems of China's basketball referee performance.
2. To draft the evaluation model for 3X3 basketball referee performance.
3. To confirm the evaluation model for 3X3 basketball referee performance.

Literature Review

Theoretical Concept of 3X3 Basketball Referees

3x3 basketball, an increasingly popular variant of traditional basketball, has distinct rules and a faster pace, requiring specific officiating skills and theoretical understanding. The unique dynamics of 3x3 basketball necessitate that referees possess not only traditional basketball refereeing skills but also an enhanced ability to manage the pace and flow of the game. This literature review explores the theoretical concepts related to 3x3 basketball refereeing, drawing from both domestic and international studies to outline the critical competencies and challenges faced by referees in this format.

The structural and rule differences between 3x3 and 5x5 basketball have significant implications for referees. According to a study by FIBA (2017), 3x3 basketball's faster pace, reduced court size, and different scoring systems require referees to adapt their positioning, decision-making speed, and understanding of game flow. This contrasts with traditional basketball, where referees have more time and space to observe and make decisions. Chinese researchers Liu and Zhang (2019) emphasized the need for specialized training for 3x3 referees, noting that the condensed game format demands quicker cognitive processing and agility in movement to maintain optimal positioning.

The cognitive load on referees in 3x3 basketball is significantly higher due to the rapid pace of the game and the continuous nature of play. In a study conducted by MacMahon et al. (2017), the decision-making processes of referees in fast-paced sports were analyzed, highlighting that referees must process information and make calls with limited time for reflection. This is particularly relevant in 3x3 basketball, where referees often face multiple situations simultaneously, requiring them to prioritize actions and maintain a high level of concentration throughout the game. Wang and Zhu (2020) further supported this by demonstrating that top-performing referees excel in multi-target tracking and quick decision-making, skills that are crucial in 3x3 basketball officiating.

Referees in 3x3 basketball must maintain high physical fitness levels to keep up with the game's tempo and ensure accurate calls. International studies by Weston et al. (2012) and Castagna et al. (2015)

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have shown that cardiovascular endurance, agility, and core strength are essential for referees to sustain performance throughout the game. In the context of 3x3 basketball, where the game is shorter but more intense, referees must be able to move quickly across the court, often without the luxury of extended breaks. A study by Li et al. (2020) in China highlighted that the physical demands of 3x3 basketball require referees to engage in targeted fitness regimes that enhance their speed, endurance, and flexibility to handle the unique challenges posed by this format. Therefore, the theoretical concept of 3x3 basketball refereeing is multifaceted, requiring a blend of cognitive, physical, and psychological competencies. The existing literature from both domestic and international sources underscores the need for specialized training and development to equip referees with the skills necessary to excel in this fast-paced format. As 3x3 basketball continues to grow in popularity, ongoing research and refinement of officiating strategies will be crucial in ensuring the quality and fairness of the game.

In the article, Mastering Enforcement Priorities in Basketball Officiating, Smith and Doe (2022) explore the critical enforcement priorities in basketball refereeing and the challenges that officials face in maintaining consistent standards. The study examines key decision-making processes, rule interpretations, and the impact of situational dynamics on officiating performance. Through a detailed analysis of game scenarios and officiating strategies, the authors provide insights into how referees can better manage enforcement during high-pressure moments. Their findings suggest that clear enforcement priorities and effective communication among officiating teams lead to improved game management and fairness. Practical recommendations for training and officiating protocols are also discussed. Moreover, in Performance Synthesis in Sports Officiating: Evaluating Progress and Potential, Miller and Thompson (2022) provide an in-depth analysis of the evolution of performance evaluation in sports officiating. The study reviews current methodologies for assessing officiating performance across various sports, identifying strengths and gaps in existing systems. Through a combination of quantitative data and qualitative feedback from officials, the research highlights the key factors that contribute to effective decision-making and consistency in officiating. The authors propose a synthesized model of performance evaluation that integrates real-time feedback, technological advancements, and ongoing training. Their findings suggest that adopting a more comprehensive performance evaluation system can significantly enhance officiating quality and fairness in sports. The study concludes with recommendations for future research and implementation strategies in sports organizations.

Jones et al. (2018) emphasized the importance of continuously evaluating referees by analyzing their performance data over an extended period. They argued that this longitudinal approach provides a more accurate reflection of a referee's capabilities, as it tracks consistency, adaptation, and improvement over time. By focusing on trends in performance rather than isolated incidents, this method allows for a deeper understanding of a referee's strengths and areas for development. Similarly, my study advocates for the inclusion of referees' historical performance as a key criterion in determining their suitability for high-level competitions, such as 3WL and satellite tournaments. Referees who demonstrate the ability to adapt, improve, and maintain a high standard of officiating over time should be prioritized for these important events, as this reflects their readiness to manage the increased pressure and complexity of high-stakes competitions.

Evaluation Model

Traditional models for evaluating basketball referees have often focused on subjective assessments by supervisors or assessors during games. According to a study by Mascarenhas (2005), these assessments typically involve rating the referee's performance on various criteria such as rule knowledge, positioning, decision-making accuracy, and game management. However, the study also highlighted the limitations of subjective evaluations, such as assessor bias and inconsistency in ratings. This has led to a growing interest in developing more objective and standardized evaluation methods.

In China, Zhang (2021) explored the traditional evaluation practices in Chinese basketball leagues, noting that while subjective assessments are common, there is a need for more structured evaluation systems. Their study emphasized the importance of incorporating multiple perspectives, including

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feedback from players and coaches, to create a more comprehensive evaluation of referees' performance.

Liang (2023) took basketball referee competence as the research object, based on the iceberg model theory of competence, and used the literature data method, mathematical statistics method, critical incident interview method, questionnaire survey method, Delphi method, analytic hierarchy process, and other research methods to construct basketball referee competence evaluation index system and determine the weight of indicators at all levels. Including 1 first-level indicator: competence; 6 second-level indicators such as on-the-spot refereeing; and 36 third-level indicators such as the ability to perceive on-the-spot information. The research determines the weights and rankings of evaluation indicators at all levels. Among them, the second-level indicators are ranked according to the weight from large to small: on-the-spot refereeing (weight 0.384), professional quality (weight 0.266), personal characteristics (weight 0.166), interpersonal communication (weight 0.086), self-improvement (weight 0.059), motivation (weight 0.037).

Yang (2021) used a variety of methods, based on the principles of purposefulness, comprehensiveness, and scientificity of the evaluation indicators, combined with football, a sport with extremely strong physical confrontation, to construct a referee performance evaluation system for football referees in Zhejiang Province including three first-level indicators, 12 second-level indicators, and 36 third-level indicators, which provides strong theoretical support for the training and selection of referees in the football world and helps the systematic adjustment and reform of football referees.

In China, the adoption of technology in referee evaluation is still in its early stages, but studies like that of Wang et al. (2021) have begun exploring the potential of using wearable technology to monitor referees' physiological responses during games. The study suggests that data collected from heart rate monitors, GPS tracking, and accelerometers could be used to assess referees' physical and mental stress levels, contributing to a more comprehensive evaluation model.

Physical Fitness for Basketball Referee

Basketball referees play a crucial role in ensuring the smooth conduct of games, maintaining fairness, and enforcing rules. Unlike players, referees do not have the luxury of being substituted during a game, requiring them to be on the court for the entire duration of play. This responsibility necessitates a high level of physical fitness to effectively perform their duties. Recent studies have explored various aspects of physical fitness and its importance in refereeing basketball, highlighting the need for strength, agility, cardiovascular endurance, and decision-making under physical stress.

Cardiovascular endurance is one of the most important components of physical fitness for basketball referees. A study by Weston et al. (2012) emphasized that referees must maintain a high level of aerobic fitness to cope with the demands of continuous running and dynamic movement throughout the game. The researchers conducted a study involving professional basketball referees and found that those with higher VO2 max levels exhibited better performance in terms of positioning and movement on the court. This finding suggests that cardiovascular endurance is directly linked to a referee's ability to keep up with the pace of the game and make accurate calls.

Referees need to demonstrate both strength and agility to move quickly across the court and position themselves optimally. According to a study by Castagna et al. (2015), agility and lower-body strength are critical for referees because these attributes enable them to change direction swiftly and maintain balance during sudden stops and starts. The study utilized agility drills and strength tests to assess the physical capabilities of referees and found a significant correlation between these attributes and the accuracy of foul calls. Moreover, referees with better agility were more likely to avoid collisions with players, which is essential for maintaining control and focus during high-intensity moments of the game.

Muscle endurance, particularly in the lower body and core, is essential for referees who need to maintain a semi-crouched position for extended periods. A study by Rontoyannis et al. (2010) highlighted that referees often experience fatigue in their legs and core muscles, which can lead to reduced concentration and slower reaction times. The study recommended specific training regimens focusing on muscle endurance and core stability, which can help referees sustain their physical performance

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throughout the game and reduce the risk of injuries associated with prolonged standing and dynamic movements.

Flexibility is another crucial aspect of physical fitness that aids in the prevention of injuries among basketball referees. A study by Mallo et al. (2011) noted that referees are susceptible to muscle strains and ligament injuries due to the rapid and often unpredictable nature of their movements. The researchers emphasized the importance of regular stretching and flexibility exercises as part of a referee's fitness routine to enhance their range of motion and reduce the likelihood of injuries. The study also found that referees who incorporated flexibility training into their routines experienced fewer muscle-related injuries during the season.

Physical fitness also plays a vital role in the cognitive functioning of referees. A study by MacMahon et al. (2007) explored how physical fatigue impacts the decision-making abilities of sports officials. The study found that referees with higher levels of physical fitness were better able to maintain cognitive performance under stress, leading to more accurate and consistent decision-making. This finding underscores the need for referees to engage in comprehensive fitness training that not only improves physical attributes but also enhances cognitive resilience under fatigue.

In conclusion, physical fitness is a fundamental requirement for basketball referees to perform their duties effectively. The literature indicates that cardiovascular endurance, strength, agility, muscle endurance, core stability, flexibility, and the ability to make decisions under physical stress are all critical components of a referee's fitness profile. Developing and maintaining these physical attributes can significantly improve a referee's performance, reduce injury risk, and enhance their ability to officiate games at a high level. Future research should continue to explore the specific training methodologies that best support these fitness components, as well as investigate the impact of fitness on referees at different levels of competition.

Conceptual Framework

The conceptual framework for this research is as follows:

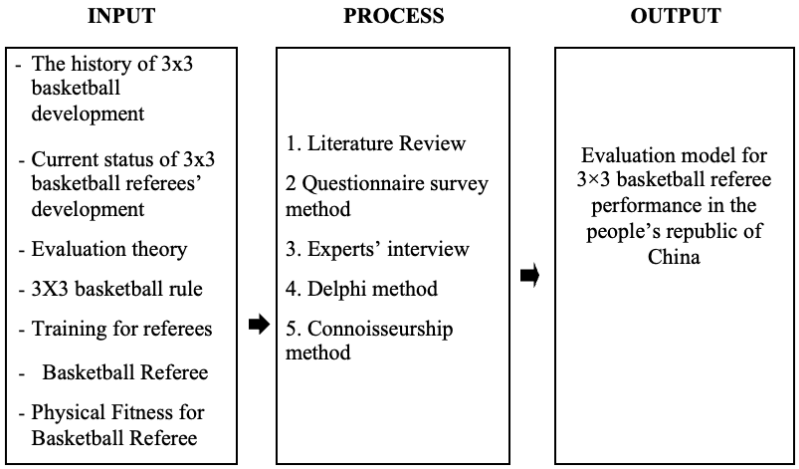

Figure 1 Conceptual framework

Methodology

Research Tools: In this research, the following tools were used to conduct the research:

1.1 Questionnaire for 3x3 Basketball
1.2 Interviewing form
1.3 Questionnaire for Delphi
1.4 Evaluation Form for Connoisseurship

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Population and Sample

Population specification and size: The population of this research consisted of 288 Chinese 3×3 basketball referees. *Sample,* the entire population of 288 Chinese 3×3 basketball referees is the sample group for this research.

Data Collection

1. Develop a questionnaire for 3x3 Basketball to survey the current situation and problems of China's basketball referee performance, conduct an IOC check on the questionnaire through 5 experts, and calculate the IOC value. The questionnaire was set to -1, 0, and +1. In this step, invite 5 IOC inspection specialists to check the validity of the questionnaire. Then collect the questionnaire and calculate the average (validity of the questionnaire = 0.60-1.00).

2. 288 questionnaires were distributed to basketball referees, coaches, and management personnel of the Chinese Basketball Association. To distribute the questionnaires, we will use an online platform to create questionnaires using the "Wenjuanxing Questionnaire System". Then, these questionnaires will be distributed and subsequently collected for data analysis.

3. Establish an expert interview schedule and conduct validity testing of the questionnaire through five experts, calculating the questionnaire's IOC value.

4. 7 experts were consulted through face-to-face interviews to discuss the current situation of China's basketball referee performance and drafting the evaluation framework for 3×3 basketball referee performance.

5. A two-round Delphi expert consensus survey was conducted among 19 experts to develop an evaluation index model for assessing the officiating performance of Chinese three-on-three basketball referees. The IOC values of the questionnaire were calculated based on the survey results.

6. 19 experts conduct two rounds of Delphi consensus to discuss and construct the evaluation model for 3×3 basketball referee performance.

In each round of Delphi consensus, the questionnaires were emailed to 19 experts, with an emphasis on the deadline for receiving the questionnaires. Check and collect the questionnaire by email when the deadline for receiving the questionnaire arrives. Data on the results of each round of consultation were then collected. Use Excel software to record the expert assignment results and suggestions.

7. Send the evaluation form to the expert for evaluation. 9 experts conduct connoisseurship to discuss and confirm the developed evaluation model for 3×3 basketball referee performance.

Data Analysis: Employ a software package to analyze data, utilizing the following statistical methods: (1) The questionnaire: Data collected is analyzed by calculating the average and standard deviation of the questions after sorting. (2) Expert Interview: Convert the content of the interview into text and organize and analyze it by using content analysis. (3) Delphi: The coefficient of variation (Cv) and the median are usually used as the evaluation criteria for screening factors. Therefore, use SPSS26.0 software to calculate the coefficient of variation (Cv) and the median successively. The criteria are that the calculated average value is greater than 3.5, and the Cv value is less than 0.25. (4) Connoisseurship: Analyze using content analysis and Rating scale. The rating criteria use the Likert five-point scale for scoring. The meanings of scale evaluation are 1 = Very Poor, 2 = Poor, 3 = Moderate,4= High, and 5 = Highest, the details of the score criteria are as follows:

Average score range	Meaning
1.00-1.79	Very Poor
1.80-2.59	Poor
2.60-3.39	Moderate
3.40-4.19	High
4.20-5.00	Highest

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Results

1. Investigating the Current Situation and Problems of Evaluating the Performance of Chinese Three-on-Three Basketball Referees

To collect data to investigate the current situation and problems of evaluation on the officiating performance of Chinese three-on-three basketball referees, this study conducted a questionnaire survey among 288 basketball referees. A total of 20 professional referees, 80 coaches, and 188 basketball teachers from three universities across the country were surveyed. The following conclusions can be drawn from the survey results:

Table 1 Survey questionnaire on the evaluation of the officiating performance of Chinese three-on-three basketball referees

Questionnaire Items	Total Score		Result
	$\bar{x}$	S.D.	
1. Is the understanding of the basic rules of referees deep enough?	3.70	0.64	High
2. Is the referee's judgment accurate?	2.90	0.54	Moderate
Do the referees have strong adaptability during the game?	3.00	0.45	Moderate
4. Does the referee have sufficient practical experience?	4.20	0.60	Highest
5. Can the referees' physical fitness cope with high-intensity matches?	2.90	0.54	Moderate
6. Is the communication ability of the referee effective?	3.40	0.49	High
7. Can the referee maintain good psychological quality and still make fair decisions under pressure?	4.50	0.60	Highest
8. Can the existing referee evaluation system comprehensively reflect the officiating ability of referees?	2.60	0.80	Moderate
9. Are the evaluation criteria objective, and do they take into account the actual conditions of different competitions?	2.30	0.46	Poor
10.Is the evaluation system based on data and actual performance?	3.90	0.70	High
11.Is there enough transparency and fairness?	3.70	0.64	High
12. Is the evaluation result widely recognized by the referees?	2.90	0.54	Moderate
13.Is the existing evaluation system easy to implement?	3.00	0.45	Moderate
14.Is the complexity of the evaluation system reasonable and convenient for referees to self-improve?	2.40	0.49	Poor
15.Is the evaluation process too cumbersome, requiring more human and material resources support?	4.20	0.60	High
16. Does the evaluation system closely integrate with the daily work of referees, reflecting actual officiating situations?	2.40	0.49	Poor
17. Does the Chinese Basketball Association place enough emphasis on the training of referees?	3.10	0.54	Moderate
18. Is there regular training and capacity enhancement activities for referees?	4.70	0.64	Highest
19. Does the association provide sufficient resources (including technology, training, support, etc.) to the referees?	3.10	0.54	Moderate
20. Does the association regularly assess the officiating level of referees?	3.88	0.86	High
21.Does the Chinese Basketball Association have a long-term plan to promote the professional development of three-on-three basketball referees?	2.12	1.43	Poor

From the survey results in Table 1, we can deduce the current status of the evaluation of the officiating performance of Chinese three-on-three basketball referees, which can be summarized into four main categories: the personal abilities of the referees, the scientificity and fairness of the evaluation system, the operability of the evaluation system, and the emphasis placed by the Chinese associations.

2. Develop the first draft of the evaluation model for 3X3 basketball referee performance

7 experts were invited to discuss the purpose of establishing a three-person basketball referee performance evaluation model and put forward the construction principles and objectives of the three-person basketball referee performance evaluation model. Based on these principles and objectives, this paper puts forward the framework that the evaluation mode should include the rules and adjudication law, the mastery of the key points of execution, the ability of execution, and the recent comprehensive evaluation. Among them, rules and referee law include three dimensions: three-person basketball rule theory, leading referee, and tracking referee (Figure 2).

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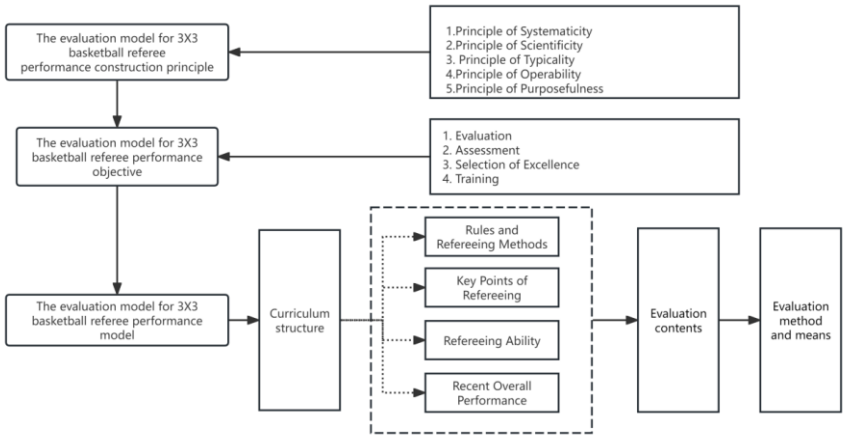

Figure 2 Construction of the evaluation model for 3X3 basketball referee performance in the People's Republic of China

The evaluation indicators selected in this paper must be capable of representing various aspects of the refereeing performance of 3x3 basketball referees in China. These indicators should be interconnected and form an organic whole with an internal structure. When selecting indicators, there must be a certain logical relationship between them. These indicators not only need to indirectly reflect the characteristics and current state of the 3x3 basketball referees in China but also reveal the internal connections of their refereeing abilities. Each subsystem has a set of indicators, which are interrelated yet independent, forming an organic unity that progresses from macro to micro, layer by layer. Only by adhering to the principle of systematicity can the evaluation indicators for the refereeing abilities of 3x3 basketball referees in China be more comprehensive and complete, thereby promoting the improvement of their refereeing abilities.

The evaluation indicators for the refereeing performance of 3x3 basketball referees in China must be constructed under the guidance of decision science theory, following a scientific construction procedure. The selection of indicators should be based on a scientific way of thinking, serving as a principle for judgment. When establishing the research framework, it is essential to have a correct direction and clear goals. In the process of collecting and initially selecting indicators, information must be comprehensive and accurate. During the indicator screening process, analysis should be appropriate, and feedback should be reasonable. The overall implementation process must be clear, measured, and systematic. The weight analysis of the indicators must be thoroughly justified and specific. In summary, only evaluation indicators for the refereeing abilities of 3x3 basketball referees in China derived from the principle of scientificity are accurate, reliable, rigorous, and objective.

The experts discussed and proposed the goal of constructing the evaluation model of three-person basketball referees' performance. Experts believe that the assessment, evaluation, promotion, training, and other objectives of three-person basketball referees should use a variety of methods and teaching, and the objectives of assessment and evaluation are similar, and the objectives of promotion and training are similar. Therefore, the evaluation model of three-person basketball referees' performance should contain three levels of elements, which are in turn evaluation objectives (first-level elements), evaluation structure (second-level elements), and evaluation content (third-level elements) as in Figure 3

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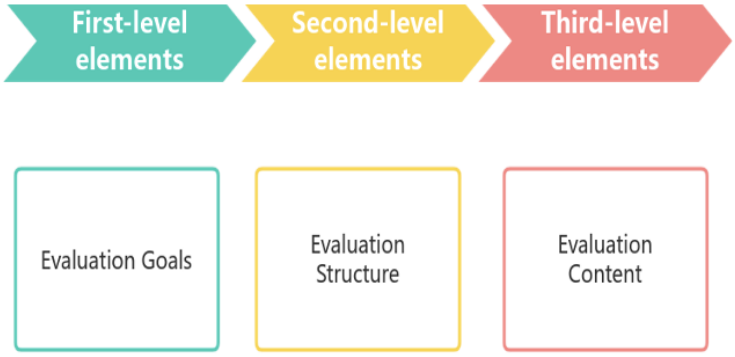

Figure 3 Frame element hierarchy diagram

3. First Round Delphi Results

In this study, 19 experts were invited to conduct a Delphi consensus. The first round of Delphi consensus results are as follows:

Table 2 Results of First-level elements

First-level elements	Cv	Median	Sreening results
A Assessment and Evaluation Scores	0.00	5	Keep
B Training and Recommendation Scores	0.09	5	Keep

Table 2 showed that the Cv values of the primary factors were all less than or equal to 0.25 and the median was all greater than 3.5. That is, all 2 First-level elements meet the retention criteria. In addition, Cv values ranged from 0 to 0.09, with a median of 5, indicating that experts had a high degree of recognition and consensus on the two First-level elements, so keep these elements.

Table 3 Results of Second-level elements

Second-level elements	***Cv***	**Median**	**Sreening results**
A1 Rules and Referee Law	0.10	5	Keep
A2 Key Officiating Skills	0.09	5	Keep
A3 Officiating Ability	0.11	5	Keep
B1 Whether to Recommend for Future Events	0.11	5	Keep
B2 Recent Comprehensive Performance	0.11	4	Keep

Table 3 showed that the Cv values of the secondary factors were all less than or equal to 0.25 and the median was all greater than 3.5. That is, all 5 Second-level elements meet the retention criteria. In addition, Cv values ranged from 0 to 0.11, and the median values were all in the range of 4 to 5, indicating that most experts have a high degree of recognition and consensus on the 5 Second-level elements, so keep these elements.

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International Journal of Sociologies and Anthropologies Science Reviews
Volume 5 Issue 2: March-April 2025: ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index

Table 4 Results of Third-level elements

Third-level elements	Cv	Median	Sreening results
A11 Rules	0.11	5	Keep
A12 Lead Referee	0.10	5	Keep
A13 Trail Referee	0.11	5	Keep
A21 traveling	0.10	5	Keep
A22 Protecting the Shooter	0.07	5	Keep
A23 Post play	0.11	5	Keep
A24 Holding and Pulling	0.10	5	Keep
A25 Screening	0.11	5	Keep
A26 Physical Contact Under the Basket	0.11	5	Keep
A27 Backing and Three-Second Violation	0.16	3	Delete
A31 Focus	0.10	5	Keep
A32 Control	0.11	5	Keep
A33 Consistency	0.10	5	Keep
A34 Communication Skills	0.11	5	Keep
A35 Confidence	0.23	5	Keep
A36 Fitness	0.20	5	Keep
B11 High-Level Competitions	0.10	5	Keep
B12 Satellite Tournaments	0.23	5	Keep
B13 3WL	0.17	3	Keep
B21 Compared to Previous Performance	0.10	5	Keep

Table 4 shows that the Cv values of the three factors are all less than and equal to 0.25, and the median is all greater than 3.5: A11 Rules, A12 Lead Referee, A13 Trail Referee, A21 traveling, A22 Protecting the Shooter, A23 Post play, A24 Holding and Pulling, A25 Screening, A26 Physical Contact Under the Basket, A31 Focus, A32 Control, A33 Consistency, A34 Communication Skills, A35 Confidence, B11 High-Level Competitions, B12 Satellite Tournaments, B13 3WL B21 Compared to Previous Performance.

B27BackingandThree-SecondViolation has a Cv value of 0.16 and a median of 3. This indicates that the rating of experts is relatively concentrated, and most experts consider this item to be important in general. Some experts have proposed that B27 Backing and Three-Second Violation does not belong to the B13 key execution control content, but belongs to the general execution control content, and should be deleted. After considering the expert's score results and suggestions, the B27 Backing and Three-Second Violation indicator was deleted.

A36Fitness had a Cv value of 0.26 with a median of 4. The results of expert ratings are slightly different, with most experts considering this item to be relatively important. Some experts put forward that according to the way of playing three-person basketball, it can be seen that three-person basketball referees need physical fitness to actively run, but this content assessment is assessed in A12 and A13. Therefore, after considering the results and recommendations of the experts, "A36Fitness" will be Kept.

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4. The second round of Delphi results

Table 5 Results of first-level elements and second-level elements

Level	Elements	*Cv*	Median	Sreening results
First-level elements	A1 Rules and Referee Law	0.00	5	Keep
	A2 Key Officiating Skills	0.10	5	Keep
	A3 Officiating Ability	0.10	5	Keep
Second-level elements	B1 Whether to Recommend for Future Events	0.09	5	Keep
	B2 Recent Comprehensive Performance	0.11	5	Keep

Table 5 shows that the Cv values of both major and minor factors are less than and equal to 0.25, and the median values are greater than 3.5. That is, 2 primary elements and 5 secondary elements all meet the retention criteria.

Table 6 Results of third-level elements

Third-level elements	Cv	Median	Sreening results
A11 Rules	0.11	5	A11,A12 merge
A12 Lead Referee	0.10	5	
A13 Trail Referee	0.11	5	Keep
A21 traveling	0.10	5	A13,A14 merge
A22 Protecting the Shooter	0.07	5	
A23 Post play	0.11	5	Keep
A24 Holding and Pulling	0.10	5	Keep
A25 Screening	0.11	5	Keep
A26 Physical Contact Under the Basket	0.11	5	Keep
A31 Focus	0.10	5	Keep
A32 Control	0.11	5	B15,B16,B17 merge
A33 Consistency	0.10	5	
A34 Communication Skills	0.11	5	
A35 Confidence	0.14	5	Keep
A36 Fitness	0.11	5	Keep
B11 High-Level Competitions	0.10	5	Keep
B12 Satellite Tournaments	0.11	5	Keep
B13 3WL	0.11	5	Keep
B21 Compared to Previous Performance	0.14	5	Keep

Table 6 shows that the Cv values of the three factors are all less than and equal to 0.25, and the median values are all greater than 3.5. That is, all three elements meet the retention criteria. The results of the recovered questionnaire show that some experts have expressed opinions on some elements. Experts propose to modify the A12 leading judge and A13 tracking judge. Merge A21 and A22 into infractions and fouls into two parts: current guide referee performance and tracking referee performance, respectively.

After the second round of expert consultation, according to the consensus opinions of experts, the framework of the three-person basketball referees' performance mode was adjusted accordingly as in Table 7.

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Table 7 The second round of Delphi consensus modify results.

First-level elements	Second-level elements	Third-level elements
A Assessment and Evaluation Scores	A1 Rules and Referee Law	A11 Rules A12 Performance of the Lead Referee A13 Performance of the Trail Referee
	A2 Key Officiating Skills	A21 traveling A22 Protecting the Shooter A23 Post play A24 Holding and Pulling A25 Screening A26 Physical Contact Under the Basket
	A3 Officiating Ability	A31 Focus A32 Control A33 Consistency A34 Communication Skills A35 Confidence A36 Fitness
B Training and Recommendation Scores	B1 Whether to Recommend for Future Events	B11 High-Level Competitions B12 Satellite Tournaments B13 3WL
	B2 Recent Comprehensive Performance	B21 Compared to Previous Performance

5. Result of Connoisseurship

In the process of constructing the evaluation model of Chinese three-man basketball referees' performance, this study adopts the method of appreciation. A Connoisseurship group of 9 experts, including referees, managers, and coaches, was selected to explore the feasibility of building a new model.

After expert appreciation (connoisseurship scoring), the evaluation model for 3X3 basketball referee performance was finally determined. It consists of 2 first-level elements, 5 second-level elements, and 19 third-level elements.

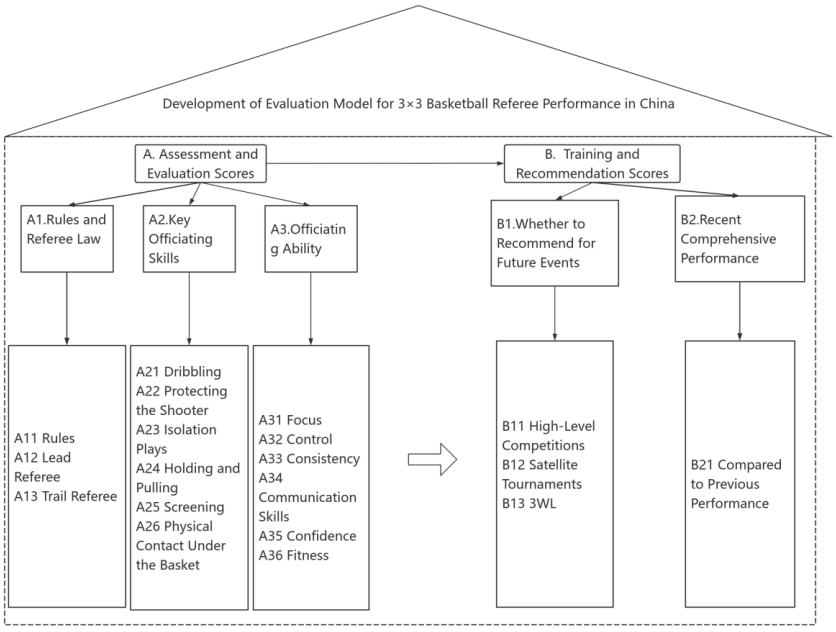

Figure 4 The Basketball Referee Performance Evaluation Model

Citation
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Conclusion

Through two rounds of the Delphi method, this study successfully designed a systematic and comprehensive evaluation model that not only focuses on the referees' current officiating abilities but also emphasizes their potential for future development. This model provides strong theoretical support for the selection, training, and promotion of referees, and the research results offer important references for the management and development strategies of Chinese 3x3 basketball referees. Overall, the evaluation system constructed in this study provides a scientific foundation for improving the officiating level and career development of Chinese 3x3 basketball referees.

Discussion

In various aspects, my research findings align closely with previous studies on referee performance evaluation, particularly in the area of key officiating skills. For example, my inclusion of "focus," "control," and "communication skills" under Officiating Ability resonates with the findings of Smith and Doe (2022), who highlighted the importance of these abilities in maintaining the flow of the game and ensuring fair play. Smith's study stressed how a referee's mental focus and ability to communicate effectively influence the game's atmosphere, which matches my results emphasizing these factors' importance in three-on-three basketball.

The emphasis on physical contact under the basketball is another area where my findings correspond with the work of Miller and Thompson (2022), who pointed out the complexity of officiating in high-contact areas. Both studies acknowledge that referees need a keen sense of situational awareness in such scenarios, where legal and illegal contact can be difficult to distinguish, especially in three-on-three basketball, where close-quarter contact is more frequent due to the smaller court and fewer players.

In terms of recommendations for future events, my findings mirror those of Jones et al. (2018), who argued for the continuous evaluation of referees based on longitudinal performance data. My study similarly advocates that referees' historical performance, especially their ability to adapt and improve over time, should play a key role in determining their suitability for future high-level competitions, such as 3WL and satellite tournaments.

Recommendation

Recommendation for this research

1. Expand the involvement of various stakeholders in the evaluation process, including players, coaches, league officials, and spectators. Their diverse perspectives can provide a more holistic understanding of referee performance in different game scenarios.

2. Conduct a comparative analysis of referee performance across different levels of competition, such as professional leagues, amateur tournaments, and youth games. This comparison can highlight differences in officiating challenges and ensure the model is adaptable to all levels.

3. Collaborate with basketball associations and referee training programs to ensure that the evaluation model aligns with both national and international officiating standards, helping to improve referee consistency and performance across competitions at different levels.

Recommendation for further research

1. Develop a continuous monitoring system for the evaluation index, allowing real-time tracking of referee performance. This can help make timely adjustments and updates to the model based on evolving rules and standards in basketball officiating.

2. Investigate the long-term effects of referee training programs and their correlation with evaluation scores. A longitudinal study could provide deeper insights into how referee training and development translate into performance improvements in real-game settings.

3. Examine cross-cultural differences by comparing how the evaluation model functions in different countries or regions, particularly those with varying basketball officiating styles and cultural approaches to sports. This could help refine the model to be more adaptable and inclusive.

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