

An Optimal Decision Making Process for Players of the Chinese Taipei National Volleyball Team



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Abstract

The primary goal of this study is to investigate the evaluation process for Chinese Taipei national volleyball team members by seeking integrated weights for systematic aspects and indicators of players in different positions, exploring the most appropriate ranking for players in various positions, and building a selection and training model for national volleyball team players. The study methods used are as follows: first, via interviews with experts and scholars, and Analytic Hierarchy Process questionnaire for evaluating the performance of players on the national volleyball team was compiled. This step was followed by the application of the AHP to an actual selection and training process for the definition of 4 systematic aspects and 15 indicators for setters, 4 systematic aspects and 14 indicators for spikers, and 3 systematic aspects and 10 indicators for liberos. The study results are as follows: the integrated weights for the aspects and indicators of players in different positions were calculated, and the most appropriate ranking for players in different positions was computed. Finally, comparing the rosters of the actual national team selectees for the 2011 Asian Men's Volleyball Championship, the accuracy rate was 100%, a result that will be an important reference for future selection and training and international competitions. Conclusion: for volleyball athletics decision-makers, this study's results provide a clear-cut tactic for development that includes priority ranking and development based on all aspects and indicators, and for the study of volleyball, brand-new application, management, analysis, and research directions.

Keywords: setters, spikers, liberos, mental, offense and defense

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Introduction

From the academic viewpoint, seeking a path to a practical and theoretical understanding of the sport of volleyball is an objective that volleyball professionals should actively pursue. A panoramic view of the correlated studies on volleyball athletics reveals that an investigation can be conducted from 3 standpoints: physiological, mental, and technical. Koch and Markus (2009) investigated men and women professional beach volleyball athletes, performing a comprehensive technical analysis of 15 men's and 14 women's matches at Klagenfurt, Austria in 2005. In this study, Chi-square tests were applied to understand performance differences between the genders. The study results suggested that 6 main elements indicate a significant difference: serving ($p < .01$), receiving a serve ($p < .05$), setting ($p < .01$), spiking ($p < .01$), blocking ($p < .01$), and defending ($p < .01$). Of these elements, serving and spiking also exhibited significant differences within the groups. Davids, Kingsbury, Bennett, and Handford (2001) investigated the main concept of information-movement coupling and combined it with experimental research and practice organization to investigate the external-time task distribution of volleyball competitors. The study results suggested that information-movement coupling is an important element in organizational structure and that the volleyball competitors' own external-time task distribution is an even more important factor in achieving the objectives of athletic action and organization.

Next, from the mental viewpoint, Lafrenière, Jowett, Vallerand, and Carbonneau (2011) applied

a Dualistic Model of Passion to investigate the influence exerted by the coach's passion on the athlete's recognition of training and the athlete's relationship with the coach. The subjects of the study were 103 coaches and athletes (volleyball, gymnastics, and soccer); the results of Structural Equation Modeling calculations suggested that a coach's training-coordinated passion has a positive influence on autonomy-supportive behavior and that an athlete's autonomy-supportive behavior also predicts a high-quality relationship between the athlete and the coach, as well as the athlete's degree of happiness. Based on organizational psychology theories, De Backer et al. (2011) investigated the recognition of the coach's justice and the needs support within a sports team. The subject of the study was the responses to a comprehensive questionnaire on the achievement of recognition and support by Belgian top-level women volleyball competitors ($N=56$; $M=22.33$). After analysis of the data via structural equations, the results suggested that the recognition of justice and needs support, along with team competitor recognition during training, reached significant levels ($p < .05$) and that team recognition positively predicted the competitor's tasks and social unity ($p < .001$) and was the intermediate for the relationship between justice and form.

As for the third part, the investigation of volleyball sports tactics and technique, the correlated studies can be said to be abundant and pluralistic (multi-elemental). These studies are characterized by different research methods, different research grounds and objects, and different technical discussion viewpoints and are of major aid and ben-

efit in training and technical practice.

In comparison with the above physiological, mental, and training and technique aspects, topics in which volleyball professionals are discussed from the “management” standpoint appear inadequate. Then discussion from the management standpoint, precisely because volleyball is a sport that is particularly focused on the team and is composed of different team members and because the evaluation of the team and its players must be considered in many respects, decision-making and correlated problem-solving are Multi-Criteria Decision Making (MCDM) theory problems. Tzeng (2003) characterized MCDM as effective in resolving the problems present in social science and noted that the correlated topics observed in our everyday lives penetrated into the multivariate inputs of MCDM theory and that decision-making programs for multivariate output projects seek a rational, feasible path toward resolution. Hence, the determination of how to penetrate objectified, quantified scientific training to enhance the performance of athletes is the main topic pursued in current training. Thus, cross-disciplinary application of the Analytic Hierarchy Process (AHP) in MCDM fully yields a resolution scheme in terms of simplifying the problem and can be considered an effective and appreciated tool. The application of this tool to athletics can be said to be increasing every day, and the concomitant results appear substantial (Bodin, & Epstein, 2000; Thomas, 2002; Bodin, 2006; Lin, Tung, Chen, & Chen, 2011). The research topics are relatively pluralistic and wide-ranging, and with regard to volleyball studies, represent even greater innovation and breakthroughs. In volleyball, Budak,

Kara, and İç (2017) used AHP to weight the positions and skills of volleyball sport; He, and Bai (2018) utilized Fuzzy Analytic Hierarchy Process based volleyball quality evaluation for college teaching; Hu, Cheng, and Wu (2018) applied Analytic Network Process (ANP) for professional volleyball development in Taiwan's sports industry.

From the viewpoint of the sports team, Zilla (1998) applied the analytic hierarchy approach to predict the ranking of the 16 soccer teams of the Israeli National League. Partovi and Corredoira (2002) presented a model with AHP and quality function deployment (QFD) for prioritizing and designing rule changes for the game of soccer to make it more attractive to soccer enthusiasts. Shahbazi, Rahimizadeh, Rajabi, and Abdolmaleki (2011) applied the AHP to discuss the mental and physical characteristics of the Iranian men's national handball team; Lee and Walsh (2011) applied a Strengths, Weaknesses, Opportunities, and Threats (SWOT) and AHP hybrid model in a case study that investigated NCAA Division I schools' outsourcing of athletic event sales for their sports teams. In recent years, the achievements of the Chinese Taipei national volleyball Team in international matches have not been prominent, and the national team's performance in international matches will directly influence the development of this sport in this country. Lin et al. (2011) applied the AHP to investigate the selection and training methods for Chinese Taipei national baseball team members. For the 2009 World Cup Baseball, they modeled an optimal pitch ranking in the selection and training process for pitchers; at the same time, they confirmed that the selec-

tion results had an accuracy rate of 91%, a rate that can serve as a reference for the selection and training of other sports teams. The purpose of this study was to examine a multiple-criteria decision making model to select appropriate players for the Chinese Taipei national volleyball team using the analytic hierarchy process.

Scientific studies on and the application of the AHP are becoming increasingly common and have yielded rich results. The research topics are relatively wide-ranging, demonstrating the importance of MCDM to the field of sports management. However, from the management standpoint, studies that investigate efficiency and productivity are relatively rare, and the selection and training methods for the Chinese Taipei national volleyball team are in need of further research to increase the effectiveness of volleyball training. Hence, determining how to investigate, via the management layer, the new research applications and directions regarding the sport of volleyball and thus provide volleyball decision-makers with a clear-cut tactic for development can be considered an important start. At the same time, the reference information on the actions of volleyball organization managers and decision-makers is of maximum aid and benefit in boosting managerial effectiveness in volleyball. Volleyball professionals should actively study the correlated measures and practices and gradually develop proper characteristics for the sport of volleyball, subsequently using them as references for volleyball competition and training practice.

Method

The AHP is a multi-objective, developmental decision method developed in 1971 by the U.S. scholar Thomas L. Saaty (1980). The main area of the AHP application is decision-making problems regarding uncertain situations and multiple assessment criteria. The hierarchical framework is the main skeleton of an entire system's framework and is used to investigate the interaction among all criteria and essential factors within the hierarchy and their influence on the entire system. Moreover, each level is only influenced by another level. The AHP simplifies a complex system into a simple and clear hierarchical system of essential factors, relies on a nominal scale for the pairwise comparison of the essential factors at all levels, and then establishes a pairwise comparison matrix. The eigenvectors used to solve for the matrix serve as priority vectors for this hierarchy and represent the priority among all essential factors. The AHP then solves for the eigenvalues, which constitute the basis for determining strength/weakness consistency in the pairwise comparison matrix for assessment and are used as the indicator of the acceptance/rejection or further assessment of a decision. The main steps of the process can be divided into 6 parts: 1. problem analysis and listing of the assessment factors; 2. construction of the hierarchical framework; 3. establishment of the pairwise matrix; 4. solving for the eigenvalues and eigenvectors; 5. verification of the consistency of the pairwise matrix; and 6. determining the dominant proportion values of all factors. In this study, the AHP provides weights for computation, and then a consistency verifica-

tion analysis is performed. Using multi-functional applications, Vaidya, and Kumar (2006) collected approximately 150 papers on the pairing of the AHP with an MCDM tool. These studies were applied in the areas of selection, evaluation, benefit-cost analysis, allocations, planning and development, priority and ranking, decision-making, forecasting, medicine, and related areas, and the AHP was applied using quality function deployment (QFD).

Selection Process for the Chinese Taipei National Volleyball Team

The present study, focusing on the 2011 Asia Cup Men's Volleyball Championship and conforming to the selection and training system of the Chinese Taipei Volleyball Association (CTVA), seeks to determine the most suitable ranking of volleyball technical capabilities and

national team members and construct a selection and training model for National Volleyball Team members. 1. To determine the views of Taiwanese volleyball professionals on the National Volleyball Team's technical capability, the present study focuses on the National Selection and Training Committee members (7 members) interviewed. 2. To determine the most suitable ranking and to build a selection model via the actual selection and training situation, this study defined 4 systematic aspects and 15 indicators for setters, 4 systematic aspects and 14 indicators for spikers, and 3 systematic aspects and 10 indicators for liberos. The present study focuses on the national team's player selection list for the 2011 Asia Cup Men's Volleyball Championship, which contains a total of 18 players (Table 1).

Table 1

The list of 2011 Asia Cup Men's Volleyball Championship necessitated the selection

no.	player	position	team
1	player 1	spiker	MIZUNO
2	player 2	spiker	MIZUNO
3	player 3	spiker	MIZUNO
4	player 4	spiker	Taiwan power
5	player 5	spiker	Taiwan power
6	player 6	spiker	Guan-yi sport
7	player 7	spiker	Guan-yi sport
8	player 8	spiker	MIZUNO
9	player 9	spiker	National Sports Training Center
10	player 10	spiker	Taiwan power
11	player 11	spiker	MIZUNO
12	player 12	spiker	Guan-yi sport
13	player 13	spiker	Taiwan power
14	player 14	setter	Guan-yi sport
15	player 15	setter	MIZUNO
16	player 16	setter	Taiwan power
17	player 17	libero	National Sports Training Center
18	player 18	libero	Guan-yi sport

Hierarchy establishment

To select and analyze nationally outstanding volleyball players, 7 National Volleyball Team Selection and Training Committee members and scholars were invited for interviews. Via these interviews with experts and the application of the AHP framework to MCDM theory, the various changes and basic situations encountered in volleyball practice were explored. A questionnaire was constructed for the evaluation of the performance of players on the National Volleyball Team. The framework of the study's hierarchical model focuses on the actual state of current outstanding volleyball athlete selection and synthesizes the views in the literature and those expressed by scholars and experts. The views can be categorized into 3 patterns: views on setters, views on spikers, and views on liberos.

During the “setters” portion, via the interviews with the experts, 4 large main systematic aspects were established: offensive and defensive statistics, setting capability, mental qualities, and individual experience. Then, under each systematic aspect, 15 assessment indicators (criteria) were constructed to complete the various basic capabilities for the optimal setter performance evaluation model and the roles they play. The evaluation framework is shown in Table 2.

During the “spikers” portion, via the interviews with the experts, 4 large main systematic aspects were established: offensive and defensive statistics, attacking capability, mental qualities, and individual experience. Then, under each systematic aspect, 14 assessment indicators (criteria) were constructed to complete the various basic capabilities for the optimal spiker performance

evaluation model and the roles they play. The evaluation framework is shown in Table 3.

During the “liberos” portion, via the interviews with the experts, 3 large main systematic aspects were established: defensive capability, mental qualities, and individual experience. Then, under each systematic aspect, 10 assessment indicators (criteria) were constructed to complete the various basic capabilities for the optimal libero performance evaluation model and the roles they play. The evaluation framework is shown in Table 4.

Measurement and Procedure

The first step used in the present study to establish the framework for the national team player selection and training model was the building of performance evaluation models for volleyball setters, spikers, and liberos (Table 1, 2, and 3, respectively) as the basis and the revision of these models for conformity with the analysis framework for actual needs. The second step was to input the correlated data on the systematic aspects (the criteria and indicators) into the AHP computer software and thus solve for the efficiency values and perform the data analysis. The third step was to input the statistical data on all selection/training athletes to be assessed into the AHP computer software to solve for the most suitable ranking. The fourth step was to obtain the most appropriate volleyball player roster for the national team.

Results

Setter aspect and criteria priorities

The results of this study indicated that all 7 experts and scholars believe that the weights and

important priorities for the setter evaluation model’s systematic aspects were as follows: “setting capability” (0.4858), “mental factors” (0.2534), “offensive and defensive statistics” (0.1463), and

“individual experience” (0.1145). The consistency ratio (CR) was 0.0796, reaching an acceptable level (Table 2).

Table 2

The setter aspect and criteria priorities

GOAL	ASPECT	CRITERIA
Setters	offensive and defensive statistics (.1463)	serving score (.1463) spiking score (.4858) blocking score (.2534) opponent’s mistake score (.1145)
	setting capability (.4858)	setting technique (.5936) attacking success rate (.1571) error rate (.2493)
	mental factors (.2534)	adjustment to pressure and handling of adversity (.1720) motivation (.1976) teachability (.1720) concentration (.2607) self-confidence (.1976)
	individual experience (.1145)	elected by media voting (.1311) coach recommendations (.6608) number of times selected as a national team player (.2081)

The weights and importance priorities for the setter evaluation model’s offensive and defensive statistics aspects were as follows: “spiking score” (0.4858), “blocking score” (0.2534), “serving score” (0.1463), and “opponent’s mistake score” (0.1145). The CR was equal to 0.0568, reaching an acceptable level.

The weights and importance priorities for the setter evaluation model’s setting capability aspects were as follows: “setting technique” (0.5936), “error rate” (0.2493), and “attacking success rate” (0.1871). The CR was equal to 0.0462, reaching an acceptable level.

The weights and importance priorities for the

setter evaluation model's mental factors aspects were as follows: "concentration" (0.5607), "self-confidence" (0.1976) and "motivation" (0.1976), and "adjustment to pressure and handling of adversity" (0.1720) and "teachability" (0.1720). The CR was equal to 0.0483, reaching an acceptable level.

The weights and importance priorities for the setter evaluation model's individual experience aspects were as follows: "coach recommendations" (0.6608), "number of times selected as a

national team player" (0.2081), and "elected by media voting" (0.1311). The CR was equal to 0.0462, reaching an acceptable level.

Spiker aspect and criteria priorities

The weights and importance priorities for the spiker evaluation model's systematic aspects were as follows: "mental factors" (0.4531), "attacking capability" (0.2616), "offensive and defensive statistics" (0.1671), and "individual experience" (0.1182). The CR was equal to 0.0957, reaching an acceptable level (Table 3).

Table 3

The spiker aspect and criteria priorities

GOAL	ASPECT	CRITERIA
	offensive and defensive statistics (.1671)	serving score (.3478) spiking score (.3478) blocking score (.0975) opponent's mistake score (.2068)
	attacking capability (.2616)	attacking success rate (.8333) error rate (.1667)
Spiker	mental factors (.4531)	adjustment to pressure and handling of adversity (.1675) motivation (.1458) teachability (.1376) concentration (.1458) self-confidence (.4033)
	individual experience (.1182)	elected by media voting (.1168) coach recommendations (.6833) number of times selected as a national team player (.1998)

The weights and importance priorities for the spiker evaluation model’s offensive and defensive statistics aspects were as follows: “serving score” (0.3478) and “spiking score” (0.3478), “opponent’s mistake score” (0.2068), and “blocking score” (0.0975). The CR was equal to 0.0224, reaching an acceptable level.

The weights and importance priorities for the spiker evaluation model’s attacking capability aspects were as follows: “attacking success rate” (0.8333) and “error rate” (0.1667). The CR was equal to 0.0000, reaching an acceptable level.

The weights and importance priorities for the spiker evaluation model’s mental factors aspects were as follows: “self-confidence” (0.4033), “adjustment to pressure and handling of adversity” (0.1675), “motivation” (0.1458) and “concentra-

tion” (0.1458), and “teachability” (0.1376). The CR was equal to 0.0448, reaching an acceptable level.

The weights and importance priorities for the spiker evaluation model’s individual experience aspects were as follows: “coach recommendations” (0.6833), “number of times selected as a national competitor” (0.1998), and “elected by media voting” (0.1168). The CR was equal to 0.0212, reaching an acceptable level.

Libero aspect and criteria priorities

The weights and importance priorities for the libero evaluation model’s systematic aspects were as follows: “defensive ability” (0.5469), “mental factors” (0.3445), and “individual experience” (0.1085). The CR was equal to 0.0462, reaching an acceptable level (Table 4).

Table 4

The libero aspect and criteria priorities

GOAL	ASPECT	CRITERIA
Libero	defensive ability (.5469)	serve receiving capability (.2500) full-dimensional defensive capability (.7500)
	mental factors (.3445)	adjustment to pressure and handling of adversity (.1720) motivation (.1976) teachability (.1720) concentration (.2607) self-confidence (.1976)
	individual experience (.1085)	elected by media voting (.1667) coach recommendations (.6667) number of times selected as a national team player (.1667)

The weights and importance priorities for the libero evaluation model's defensive statistics aspect were as follows: "full-dimensional defensive capability" (0.7500) and "serve receiving capability" (0.2500). The CR was equal to 0.0000, reaching an acceptable level.

The weights and importance priorities for the libero evaluation model's mental factors aspects were as follows: "concentration" (0.2607), "self-confidence" (0.1976) and "motivation" (0.1976), and "adjustment to pressure and handling of adversity" (0.1720) and "teachability" (0.1720). The CR was equal to 0.0392, reaching an acceptable level.

The weights and importance priorities for the libero evaluation model's individual experience aspects were as follows: "coach recommendations" (0.6667), "elected by media voting" (0.1667), and "number of times selected as a national competitor" (0.1667). The CR was equal to 0.0000, reaching an acceptable level.

Ranking of players

The development of the national team roster for the 2011 Asia Cup Men's Volleyball Championship necessitated the selection of 18 players. For privacy, their full names are not made public, and the players are referred to by code names (as Table 1).

The setter integrated assessment weight necessitated solving for the relative weights of the 15 setter assessment indicators (criteria), and after their comparative appraisal by the experts, solving for the setter integrated indicator weight and most suitable ranking. For the setter portion, a total of 3 players were selected for the 2011 Asia Cup Men's Volleyball Championship national team. Table 5 lists the most suitable ranking and weighted aggregate score for the optimal setters as national team players: 1, player 16 (6.950); 2, player 15 (6.821); 3, player 14 (6.560). Players 15 and 16 were selected for the 12-player final roster. The results of this study are thus consistent with the actual selection and training results.

Table 5

The ranking and weighted aggregate score for the optimal setters

no.	weight score	rank
player 14	6.560	3
player 15*	6.821	2
player 16*	6.950	1

Note: * represents players were selected for the final roster

The spiker portion involved the relative weights for the 14 assessment indicators (criteria), and after the experts' comparative appraisal, solving for the integrated indicator weight and most suitable ranking for the spikers. A total of 13 spikers were selected for the 2011 Asia Cup Men's Volleyball Championship national team. Table 6 lists the most suitable ranking and the weighted aggregate score for the optimal spikers as national team players: 1, player 1 (7.156); 2,

player 4 (7.119); 3, player 5 (6.859); 4-5, player 2 and player 6 (6.815); 6, player 12 (6.811); 7, player 10 (6.780); 8, player 7 (6.774); 9, player 11 (6.722); 10, player 8 (6.665); 11, player 3 (6.611); 12, player 13 (6.520); 13, player 9 (6.305). Nine players, 1, 2, 4, 5, 6, 7, 10, 11, and 12, were selected for the 12-player final roster. The results of this study are thus consistent with the actual selection and training results.

Table 6

The ranking and weighted aggregate score for the optimal spikers

no.	weight score	rank
player 1*	7.156	1
player 2*	6.815	4
player 3	6.611	11
player 4*	7.119	2
player 5*	6.859	3
player 6*	6.815	4
player 7*	6.774	8
player 8	6.665	10
player 9	6.305	13
player 10*	6.780	7
player 11*	6.722	9
player 12*	6.811	6
player 13	6.520	12

Note: * represents players were selected for the final roster

The liberos portion involved the relative weights for the 10 assessment indicators, and after the experts' comparative appraisal, solving for the integrated indicator weightings and most suitable ranking for the liberos. For the libero portion, a total of 2 players were selected for the national team at the 2011 Asia Cup Men's Vol-

leyball Championship. Table 7 shows the most suitable ranking and the weighted aggregate score for the optimal liberos as national team players: 1, player 18 (7.381) and 2, player 17 (7.092). Player 18 was selected for the 12-player final roster. The present study's results are thus consistent with the actual selection and training results.

Table 7

The ranking and weighted aggregate score for the optimal liberos

no.	weight score	rank
player 17	7.092	2
player 18*	7.381	1

Note: * represents players were selected for the final roster

Discussion

Conclusions

1. The sport of volleyball has a history of more than 100 years and is popular around the world.
2. At home and abroad, correlated studies on the sport of volleyball also emphasize the importance of athletes' mental hierarchy, and volleyball professionals should actively study correlated foreign measures and practices to develop appropriate characteristics for the sport of volleyball in Taiwan.
3. The correlated studies of tactics and techniques in volleyball have been the focus of scholarly studies and can serve as competition and training references.
4. The relative insufficiency of researches and development investigating the sport of volleyball from the management standpoint increases the

importance of this study's investigation of studies on the selection of a national team.

5. The studies on and the application of the AHP by athletics and scholars can be said to be increasingly widespread and their achievements abundant. The study topics are relatively pluralistic and wide-ranging and are deserving of notice from scholars or researchers.

Suggestions

This study investigated a team-member selection model for the National Volleyball Team and sought the development of offensive and defensive statistics and critical capabilities for the sport of volleyball. As the first Taiwanese volleyball research paper written from the standpoint of management and applying MCDM theory to the development of volleyball practices, this study can be considered an important research foundation.

In investigating the training standpoint, the importance of systematic aspects and indicators for players in all positions (setters, spikers, and liberos) and the ranking results have provided the most important and most directly referenced information for decision-makers and managers (on the selection and training committee and among coaches) to use when formulating decisions. In terms of players, the research has provided the most objective keys to enhancing targets and directions.

In investigating the selection and training standpoint, the most suitable ranking of and statistics on volleyball players provide a scientific management basis for enhancing the selection and training of the national volleyball team. The results are not the only objective but also capable of resolving the long-standing problem wherein the selection and training system used for National Team members has tended to exert subjective and inflexible effects. Similarly, the results will have an optimal influence on the enhancement of the Taiwanese volleyball technique.

The investigation of critical capabilities in volleyball has contributed to many areas—selection, training, competition, the derivation of tactics, and even the development of the sport of volleyball in this country. In follow-up studies, researchers should strive to vigorously forge ahead with this investigation.

The national volleyball team member selection model constructed in the present study has been tested via a questionnaire completed by experts and through the application of the AHP. The AHP can not only convert the recognition and reactions

of volleyball experts, and scholars into (statistical) weights, providing relative importance information and rankings, but also be considered a case in which practice and theory allow for combination and verification. This capability will be of much assistance and benefit to the practice of the sport of volleyball.

The studies on and application of the AHP by scholars about the subject of volleyball can be said to be increasingly widespread and their achievements abundant. The research topics are relatively pluralistic and wide-ranging and can be considered topics of continuing interest to Taiwanese professionals involved in the sport of volleyball. The present investigation of volleyball's critical capabilities has contributed to many areas—selection, training, competition, the derivation of tactics, and even the development of the sport of volleyball in this country, and through continuing efforts, should continue to be developed to a higher level in follow-up studies. At the same time, future research can extend the investigation to the application of different hierarchies of Taiwanese player selection and training or comparative studies of volleyball in different nations and areas. Also, future studies can be oriented toward sequential development and the expanded collection of panel data for a cross-section of different times to produce important references and applications for the improvement of practices used in the sport of volleyball.

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