Research on comprehensive evaluation model-based NBA schedule influences on team performance

Dawei Shi

Department of Physical Education, Hebei University of Technology, Tianjin, China
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ABSTRACT

Schedule has different effects on team competitive result to some extent; therefore reasonable and scientific schedule should not only reflect equity of competition but also increase the splendid degrees of competition. This paper makes detailed analysis of proper influences conditions that NBA regular season schedule affects competition in order to get a reasonable comprehensive evaluation to schedule through analysis and then achieve schedule optimized scheme. At first establish schedule evaluation comprehensive model through impact analysis of schedule affects team competitiveness, then utilize evaluation model to make comprehensive evaluation on each team schedule and get evaluation results, finally establish schedule optimized model through extracting unreasonable factors of schedule based on evaluation results, and achieve fighting strategies of eastern conference same section different regions competitions to provide theoretical basis for NBA schedule and schedule aspect orientation for NBA season reform.

Key words: Comprehensive evaluation model, optimization design, impact weight, NBA schedule
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INTRODUCTION

In 1873 badminton movement was born in England; after 100 years of vigorous development, badminton has become a very popular sports project in the world; badminton can fully exercise the body and enhance functions of the human body. Whether it's a regular badminton game or as a general fitness activity, they should conduct footwork, jump, twist and swing on the ground without break [1, 2]; rational use of various hitting techniques and the footwork to strike the ball back and force on the court, thereby increasing strength of the arms, legs and waist muscles, accelerating the systemic blood circulation of the exercise, enhancing the function.

NBA competition is one of worldwide basketball fans favorite competitions. To NBA such a enormous competition, it is a very complicated thing to compile a completed and equitable schedule to each team as far as possible. Schedule has a certain effect on team strength playing and standings, therefore as whole world basketball fans cared NBA regular season, reasonable schedule arrangements of fond teams are expected. To show schedule equity and fight splendid, this paper analyzes schedule that affects team competitiveness playing so as to get reasonable schedule evaluation model and schedule optimized model and provide orientation and theoretical basis for NBA schedule reform [3-6].

For NBA schedule evaluation and optimization research, lots of people have made efforts, thoughts and results that they put forward are continuously verifying by NBA competitions. Among them, Xu Jing(2009) Adopts analytic hierarchy process to systematically analysis of NBA2008-2009 seasons competition equity issues, brings into schedule pros and cons comprehensive index to measure pros and cons that schedule affects each team, and designs relative scientific competition schemes[1]; Zeng Yu-Hua(2009) Makes analysis and evaluation on NBA schedule by combining with national college students mathematical modeling competition question D, puts forward a set of new method as type matching for NBA schedule participating three courts secondary teams all conditions by achieving

main factors that affect competition with statistics analysis and fitting methods[2]; Zhang Yu-Lan(2011)According to seasons schedule and competition result, takes comprehensive considerations of teams strength wide gap degree, home and guest courts, scores difference between two teams total 3 factors, puts forward teams scheme and algorithm of selecting 3 courts in one season, and achieve specific competition scheme through programming solution with language C [3].

NBA is an enormous competition, and schedule has a certain effect on teams' strength playing and standings, therefore it is a very complicated thing to make completed and equal schedule so as to eliminate players, coaches and medias complains to schedule. This paper based on previous studies, makes analysis of NBA schedule influences on players and team, explores schedule evaluation model based on one team, and establish NBA schedule comprehensive evaluation model in order to put forward more reasonable and scientific NBA schedule planning through model analysis and provide data basis and research objects for season optimization design.

NBA SCHEDULE ANALYSIS AND EVALUATION METHODS
The purpose of analyze NBA schedule is to eliminate inequality of competition and improve splendid degree of competition. To analyze schedule pros and cons to one team, many factors should be considered. If these factors can be extracted and used to convert schedule into quantitative index that easier for mathematical handling, it would provide great help for schedule evaluation. This paper summarizes six typical conditions and analyzes them accordingly so as to achieve purpose of NBA schedule analysis [4].

NBA schedule analysis
Adjacent games interval time: Basketball game is an event different from other sport ones, its physical output basically just second to that of football game; While one event as NBA which is very normal and has global coverage, not only should provide audience the most wonderful game, but also should ensure players have a reasonable rest time and physical adjust time after court. However, there are two disputes existing on rest time planning, one is so long rest time that rating books and economic benefits are affected ; the other is so short rest time that players can not show audience   a wonderful game. Due to above two conditions constraints, balance points between the two should be acquired in schedule so as not favor one over another [5].

Home or guest court impacts on competition: In NBA basketball competition, home or guest court plays a role in teams' competition. The home court advantage refers to that players play with other teams in the city that its team belongs to so that gets rid of toiling away by long journey, sleeping late waking up early before competition as well as troubles like inconvenient eating and lodging; Meanwhile, competition court is the place with which they themselves most familiar and even take training, their adaptation in spot, light hoop, climate and scene atmosphere have advantages over the opponents. To sum up, above factors indicates that fight in home or guest court plays a certain role in team competition, therefore in schedule of regular seasons should consider which team first plays in home court which team first plays in guest court, times of home and guest courts and so on [7].

Analysis of intervals between home and guest court: Intervals between home and guest court refers to players' rest time; Due to regular season has a fixed starting and ending time in competition, and each team must complete 82 competitions in given time, therefore limited time should be made full use for letting players physical quality get best rest and adjust as much as possible. Intervals between home and guest court means player s should change competition court, in this case tired journey and psychological influence is invariable generated, so intervals between home and guest court would also be regarded one of important indicators to evaluate schedule [8].

Analysis of competitions in same section different regions: There are two playing methods for same section but different regions team, one is to play 3 courts, and the other is to play 4 courts. Mainly concerns in choosing whether 3 courts or 4 courts playing is such team physical strength condition, ten teams will carry out 36 courts competitions, partial teams would play 3 courts while others play 4 courts, while numbers of coming across strong teams in competition is one important factor that affect teams' standings, every team would hope itself comes across weak team as much as possible so as to increase their team probability of entering playoffs. Since every team would play respectively 2 courts with teams in different section and play 4 courts with teams in same regions, such two playing method are fixed, only in same section but different regions such stage they can have play with weak team as much as possible, therefore the schedule allocation of same section different regions directly impacts on them whether can enter into playoffs or not.

Analysis of participating team strength: The strength o teams is one important factors that affects their development ; In every stage, NBA would rank the teams, teams rankings play a special important role in teams development, but based on the limits of teams strength, teams without stronger strength should make efforts to schedule so as to achieve better regular season ranking. Because in regular season, it is required to play with every team from whole

alliance, teams would hope they themselves come across stronger team as less as possible, while play with weaker team as more as possible. So evaluate schedule pros and cons to some team, first should consider such team overall strength and then think about excellent players' strength in the team.

Analysis of "back to back" playing: "Back to Back" is a regular playing in NBA, due to every team geographical distribution causes, usually one team would join the game in other cities. In order to reduce players' inconveniences that led by court transferring as much as possible, the regular back-to-back playing as "home-guest-guest-home" and "guest-home-home-guest" are applied. Such application is to reduce team court transferring times so that can increase rest time and improve competition quality.

NBA schedule evaluation methods

NBA is a competitive event; team's playoffs entry is an important factor that affects team development, normally playoff selection is depend on regular season performance ranking, while regular season ranking method is according to each team victory and fail courts in regular season, in case that victory and fail court are the same, scores, loss and gap between scores and loss as well as every home and guest court standings should be considered to make comprehensive evaluation to get each team ranking, finally select out teams that enter into playoff. To every team, it first should to play respectively   in one home one guest total 30 courts competitions with 15 teams from different sections, then carries out two homes and two guests with 4 teams from different regions total 16 courts competitions, such two items total 46 courts competitions is fixed. For above 46 courts competitions, only need to consider which party first plays in home court and team itself strength such two factors, while the rest 36 courts competition need to make groups assembly .Due to 4 courts and 3 courts playing occur to same section different regions competitions, according to calculation, it is got that all alliance would have 6 teams to play 4 courts competitions and 4 teams to play 3 court competitions. To 4 courts competitions and 3 courts competitions, its own side comes across strong teams numbers should be taken into fully consideration, then the two start play games and get merits of teams by schedule arrangements.

According to calculation, it is got that 6 teams play 3 courts and 4 teams play 4 courts in same section different regions schedule. This paper selects y_i as variables from 0 to 1, when comes across strong team, y_i takes 1, on the contrary takes 0.In the teams that selected to play 4 courts, assume that a teams are stronger than itself in strength, while b teams are stronger than itself in strength in teams to play 3 courts, then relationship is as formula (1) shows.

$$a = \sum_{i=1}^{6} y_i, b = \sum_{i=1}^{4} y_i$$

(1)

If make comparison in numbers of strong teams that comes across in 3 courts competitions and 4 courts competitions, then take times of coming across strong team and teams numbers in playing 3 courts to evaluate the two ratio in 3 courts competitions, get proportions of coming across strong team in 3 court competitions. Similarly can get proportions of coming   across strong team in 4 courts competitions, then let proportion of coming across strong team in 3 courts competitions to minus that in 4 courts competitions to work out which teams come across strong team for more times so that can get teams merits in the following competitions development. Use P to represent different value, as formula (2) shows.

$$P_i = \frac{a}{6} - \frac{b}{4} = \frac{1}{6}\sum_{j=1}^{6} y_j - \frac{1}{4}\sum_{j=1}^{4} y_j$$

(2)

In order to get whole alliance each team comes across strong teams' advantage weight, take Q_i to represent the weight, as formula (3) shows.

$$Q_i = \frac{p_i}{\sum_{j=1}^{30} p_j} \times 100\% \qquad i = 1,2,\cdots,30$$

(3)

Organize each team each competition's rest time intervals can work out total rest time in each competition, then use total rest time divides rest intervals in competition. Due to every team has 82 courts competitions, its rest intervals is

81 times, then can use competition total rest time divides rest times to get average rest time in each competition, work out such time as $t = 1.9753$ day through calculation, then with this time intervals as reference, make comparison with each rest intervals in each competition, the more closer that time intervals to reference time, the more benefit that team would be .Make superposition of differences between team total time intervals and reference intervals can get each team time intervals quantity, then according to the reference, make ranking on team pros and cons conditions in time intervals, its concrete indicator F_i computational form is as Formula (4) shows.

$$F_i = \frac{x_i}{\sum_{j=1}^{30} x_j} \times 100\% \qquad i = 1,2,\cdots,30$$

(4)

Similarly can get time allocation pros and cons weight M_i to team based on scene transfer and scene not transfer, continuous home court quantity pros and cons weight S_i to team and First time playing in the home court pros and cons weight K_i to team, as formula (5) shows . From which, $i = 1,2,\cdots,30$.

$$M_i = \frac{m_i}{\sum_{j=1}^{30} m_j} \times 100\%, S_i = \frac{s_i}{\sum_{j=1}^{30} s_j} \times 100\%, K_i = \frac{41-x_i}{\sum_{j=1}^{30}(41-x_i)} \times 100\%$$

(5)

It can be concluded comprehensive evaluation indicator A_i that schedule affects competition, its express is as formula (6) shows.

$$A_i = \frac{Z_i}{\sum_{j=1}^{30} Z_j} \times 100\% = \frac{Q_i + F_i + M_i + K_i + S_i}{\sum_{j=1}^{30}(Q_i + F_i + M_i + K_i + S_i)} \times 100\%$$

(6)

NBA SCHEDULE OPTIMIZATION DESIGN
NBA evaluation result
To make evaluation of schedule advantages and disadvantages, firstly should define with which teams each time plays 3 courts and plays 4 courts, through data handling and then according to its result make respective contrasting and list out which teams strengths are stronger than own side team as well as which teams are weaker than own side. Bring statistics results into formula (3) can get opponent allocation affects team in 3 courts and 4 courts playing as Table 1 show.

Table 1: opponent allocation influences on team standings based on 3 courts and 4 courts

Team	Evaluation	Team	Evaluation	Team	Evaluation	Team	Evaluation	Team	Evaluation
Celtics	-1.090	Lakers	-1.090	Spurs	-0.272	Suns	-0.363	Magic	-0.636
Nuggets	0.1818	Cavaliers	-0.090	Brave dragons	-0.181	76ers	-0.181	Hawks	0.0000
Nets	0.2727	Bobcats	0.7272	Knickerbockers	0.8181	Grizzlies	0.6363	Supersonics	1.0909
Pistons	-0.909	Hornets	-0.909	Rockets	-0.909	Jazz	0.0909	Mavericks	-0.454
Warriors	0.1818	Wizards	-0.454	Trailblazers	0.4545	Kings	0.4545	Pacers	0.0909
Bulls	0.3636	Bucks	0.6363	Clippers	0.3636	Timberwolves	1.0909	Heat	1.0909

Team pros and cons based on time intervals can be got from formula (4), and its result as Table (2) show.

Table 2: Team pros and cons conditions based on time intervals

Team	Evaluation	Team	Evaluation	Team	Evaluation	Team	Evaluation	Team	Evaluation
Celtics	3.12%	Lakers	3.50%	Spurs	3.35%	Suns	3.20%	Magic	3.04%
Nuggets	3.35%	Cavaliers	3.20%	Brave dragons	3.35%	76ers	3.80%	Hawks	3.65%
Nets	3.80%	Bobcats	3.27%	Knickerbockers	2.74%	Grizzlies	3.65%	Supersonics	3.35%
Pistons	2.74%	Hornets	3.50%	Rockets	3.50%	Jazz	3.42%	Mavericks	2.82%
Warriors	2.74%	Wizards	2.89%	Trailblazers	3.12%	Kings	3.50%	Pacers	3.50%
Bulls	3.37	Bucks	3.73%	Clippers	3.50%	Timberwolves	3.65%	Heat	3.43%

Competition pros and cons conditions based on home and guest courts is as Table 3 shows.

Table 3: Competition pros and cons conditions based on home and guest courts

Team	Total value	Weight	Team	Total value	Weight	Team	Total value	Weight
Celtics	144	3.70%	Lakers	136	3.50%	Spurs	129	3.30%
Nuggets	108	2.80%	Cavaliers	118	3.00%	Brave dragons	155	4.00%
Nets	133	3.40%	Bobcats	155	4.00%	Knickerbockers	172	4.40%
Pistons	131	3.30%	Hornets	125	3.20%	Rockets	125	3.20%
Warriors	121	3.10%	Wizards	116	3.00%	Trailblazers	147	3.80%
Bulls	112	2.80%	Bucks	95	2.40%	Clippers	93	2.40%
Suns	183	4.70%	Jazz	155	4.00%	Magic	131	3.40%
76ers	129	3.30%	Kings	119	3.00%	Hawks	104	2.70%
Grizzlies	99	2.50%	Timberwolves	146	3.70%	Supersonics	127	3.20%
Mavericks	112	2.80%	Pacers	135	3.50%	Heat	155	3.90%

Competition pros and cons conditions based on first competition in home court is as Table 4 shows.

Table 4: Competition pros and cons conditions based on first competition in home court

Team	Weight	Team	Weight	Team	Weight	Team	Weight	Team	Weight
Celtics	4.02%	Lakers	3.83%	Spurs	4.06%	Suns	2.70%	Magic	3.61%
Nuggets	3.38%	Cavaliers	3.61%	Brave dragons	2.70%	76ers	2.70%	Hawks	2.48%
Nets	3.38%	Bobcats	4.51%	Knickerbockers	3.16%	Grizzlies	3.16%	Supersonics	3.38%
Pistons	3.83%	Hornets	3.16%	Rockets	2.93%	Jazz	3.83%	Mavericks	2.93%
Warriors	2.25%	Wizards	4.06%	Trailblazers	2.48%	Kings	3.83%	Pacers	2.70%
Bulls	2.93%	Bucks	1.80%	Clippers	3.38%	Timberwolves	3.61%	Heat	5.41%

Competition pros and cons conditions based on rest time generated by scene transferring is as Table 5 shows.

Table 5: Competition pros and cons conditions based on scene transferring

Team	Weight	Team	Weight	Team	Weight	Team	Weight	Team	Weight
Celtics	3.56%	Lakers	6.18%	Spurs	3.56%	Suns	4.77%	Magic	2.25%
Nuggets	5.34%	Cavaliers	-0.43%	Brave dragons	-6.78%	76ers	5.53%	Hawks	3.87%
Nets	2.50%	Bobcats	3.23%	Knickerbockers	3.38%	Grizzlies	4.21%	Supersonics	1.52%
Pistons	2.36%	Hornets	6.18%	Rockets	5.00%	Jazz	1.46%	Mavericks	2.77%
Warriors	1.89%	Wizards	2.37%	Trailblazers	5.20%	Kings	5.41%	Pacers	3.43%
Bulls	1.52%	Bucks	6.77%	Clippers	5.34%	Timberwolves	3.05%	Heat	4.41%

Bring 5 tables data into formula (6) can get schedule pros and cons degree to each team, the smaller the value is the better the team would be, the bigger the value is the worse the team would be, the best and worst teams meet the formula (7).

$$Best = \min\{A_1, A_2, \cdots, A_{30}\}; Worst = \max\{A_1, A_2, \cdots, A_{30}\}$$

(7)

In formula (7), $Best$ shows the best team in schedule, $Worst$ shows the worst team in schedule, overall result is as Table 6 shows.

Table 6: Table of schedule comprehensive evaluation result

Team	Result	Team	Result	Team	Result	Team	Result	Team	Result
Celtics	-0.9459	Lakers	-0.91985	Spurs	-0.12927	Suns	-0.2093	Magic	-0.51597
Nuggets	0.330566	Cavaliers	0.006109	Brave dragons	-0.15132	76ers	-0.0276	Hawks	0.127075
Nets	0.403599	Bobcats	0.877346	Knickerbockers	0.956456	Grizzlies	0.771575	Supersonics	1.205466
Pistons	-0.78663	Hornets	-0.74855	Rockets	-0.76265	Jazz	0.21807	Mavericks	-0.34079
Warriors	0.281632	Wizards	-0.3277	Trailblazers	0.600599	Kings	0.611951	Pacers	0.222251
Bulls	0.473457	Bucks	0.783357	Clippers	0.509851	Timberwolves	1.231075	Heat	1.2558

From final result in Table 6, it can be known that schedule is best for Celtics, while worst for Heat.

NBA schedule optimization design method
In order to make optimization design of schedule, firstly should analyze schedule influence factors from competition area overall strength, every competition area overall strength is depend on each team overall strength; it can be known from comprehensive evaluation of schedule that average winning percentage in every competition area basically remain in around 50%, southwest alliance team have the highest winning percentage of 58.54%, while southeast team have the lowest winning percentage of 43.64%, other every competition area overall level has less deviation. It can be concluded that each competition area overall strength has slightest impact on schedule, so that it

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can be ignored. Concentrate research on team strength should take comprehensive consideration of 5 aspects as winning percentage, winning differences, sub region winning percentage, sub section winning percentage, home and guest courts winning percentage, and make quantization of them, from which winning percentage entirely can reflect victory ratio without considering any objective things, reflects team last season victory or defeat conditions; winning differences reflect team's strength conditions in its own sub region; sub region winning percentage reflects such team strength inside regions, sub section winning percentage reflects victory or defeat conditions inside sections, home and guest courts winning percentage reflects team adaptation ability as well as other comprehensive qualities, therefore victory and defeat times are key factors to measure one team strength. In case that victory and defeat times cannot make integrated sequence of team strength, factors as winning differences, sub region winning percentage, sub section winning percentage as well as home and guest courts winning percentage should be used to make strength evaluation ranking to team.

When arranges 3 courts playing schedule, it should take fully consideration of each team overall level that has same section with its own side but different regions from its own side, from which teams with the slightest differences in overall levels should be arranged in 3 courts playing as much as possible, meanwhile should also think about team level's balance problem. To keep equity among teams, each team quantity and strength such two aspects balance should be remained and consider constraints of competition courts. In conclusion, schedule optimization model can be reflected in formula (8).

$$
\min = \sum_{h=1}^{3} e_h
$$

$$
\begin{cases}
e_1 = \sum_{i=1}^{5} \sum_{j=1}^{10} \left(a1_i - b1_j \right) \cdot k1_i \\
e_2 = \sum_{i=1}^{5} \sum_{j=1}^{10} \left(a2_i - b2_j \right) \cdot k2_i \\
e_3 = \sum_{i=1}^{5} \sum_{j=1}^{10} \left(a3_i - b3_j \right) \cdot k3_i \\
\sum_{n=1}^{3} \sum_{i=1}^{5} kn_i = 2
\end{cases}
$$

$$(8)$$

In formula (8), e_h shows one region in same section, a_i shows winning percentage in one region, b_j shows the rest two regions winning percentage, k_i shows variable from 0 to 1, objective function in optimization model indicates the strength difference between every two teams is the minimum one, which is to say comparable teams play games that is a close competition which can meet equity of schedule and also show wonderful confrontation views.

NBA schedule optimization design result
Utilize optimization model in formula (8), it can be got optimization design scheme of 15 teams in same section play 3 courts competitions with corresponding other two regions two teams as Table 7 shows, take result reference of eastern conference.

Table 7: Eastern conference same section different regions 3 courts playing optimization design result and fighting table

Celtics VS	Pistons	Brave dragons VS	Pistons	76ers VS	Magic
	Cavaliers		Cavaliers		Wizard
	Pacers		Pacers		Bulls
	Bucks		Bulls		Bucks
Pacers VS	Magic	Cavaliers VS	Brave dragons	Pistons VS	Celtics
	Wizard		76ers		Brave dragons
	Celtics		Nets		76ers
	Nets		Knickerbockers		Knickerbockers
Magic VS	Pistons	Wizard VS	Pistons	Hawks VS	Celtics
	Pacers		Pacers		Brave dragons
	Bulls		Bulls		Cavaliers
	Bucks		Bucks		Pacers
Bobcats VS	Brave dragons	Nets VS	Wizard	Bucks VS	Wizard
	76ers		Hawks		Hawks
	Nets		Bobcats		Bobcats
	Knickerbockers		Heat		Heat
Bulls VS	Magic	Knickerbockers VS	Magic	Heat VS	Celtics
	Hawks		Hawks		76 人
	Bobcats		Bobcats		Nets
	Heat		Heat		Knickerbockers

CONCLUSION

This paper made 5 aspects analysis of pros and cons that schedule affects team after entering into playoff, and utilized mathematical modeling method and mathematical statistics method to make quantization of each aspect factors. This paper established comprehensive evaluation model that schedule influences on team, and pros and cons result that schedule affects on participating 30 teams by such model. Through analysis pros and cons result and influence factors that schedule produced to team, established schedule optimization design model, such model took minimum difference between every fighting parties as objective function with the purpose of equity reflection and fighting white-hot improvement, got fighting planning schemes of eastern alliance same section different regions after optimized.

REFERENCES

[1] Xu Jing. *Journal of Kiamusze University*, **2009**, 27(4), 566-569.
[2] Zeng Yu-Hua etc. *Journal of Chongqing institute of technology*, **2009**, 11(2), 157-164.
[3] Zhang Yu-Lan. *Gansu science and technology*, **2011**, 27(2), 42-43.
[4] Zhang B.; Feng Y.. *International Journal of Applied Mathematics and Statistics*, **2013**, 40(10), 136-143.
[5] Dong Dong-Feng. *Journal of Changsha institute of communication technology*, **2008**, 7(2).
[6] Zhang B.; Zhang S.; Lu G.. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(9), 256-262.
[7] Zhang B.; *International Journal of Applied Mathematics and Statistics*, **2013**, 44(14), 422-430.
[8] Zhang B.; Yue H.. *International Journal of Applied Mathematics and Statistics*, **2013**, 40(10), 469-476.