USING DEA TO ASSESS THE EFFICIENCY OF HANDBALL TEAMS

Gutiérrez Aguilar, Óscar[1]; Ruiz Gómez, José Luis[1]; Ramis Claver, Jaime[1]
[1] University Miguel Hernández (Elche, Spain)

ABSTRACT

This article shows how Data Envelopment Analysis (DEA) can be used to identify a model of effective team. Statistical data of the national teams participating in the Men's World Handball Championship held in Sweden in 2011 was analyzed.
The results showed that 9 of the 24 teams were efficient, revealing that each of them reached the efficiency model with a different pattern of game. Likewise, inefficient teams showed their weaknesses, and DEA indicated possible areas for improvement.
Finally, a comparison was made between the classification achieved by each team in the World Championship and the ranking prepared by the coefficient of efficiency obtained complemented with a cross-efficiency evaluation. With few exceptions, both classifications are very similar.

KEYWORDS

Handball, efficiency. Perfomance, Data Envelopment Analysis.

INTRODUCTION

There are several articles designed to determine which indexes are more representative or which may be more significant for the analysis of tactics. A recurring line of research seeks distinctive performance variables of the winning teams, so they can be compared with the losing teams for efficient game models.
In this sense, different studies have been carried out on team sports such as basketball (Sampaio & Janeira, 2003), football or rugby (Ortega, Villarejo & Palao, 2009). In other cases, the differences between winners and losers has been evaluated taking into account the variable of gender, class or both (Sampaio, Ibáñez & Feu, 2004).
Similarly, in the handball there are several studies that evaluate the efficiency indices based on tactical tactical statistical or modulate these indicators by category studied.
However, analysis of statistics from several teams in a competition or a team in a match can lead to biased conclusions. Teams with different strategies, approaches and typologies produce different tactical indexes (Gruic, Dinko & Dragan, 2006). Therefore, a pre-set pattern of game cannot be imposed on all teams. An evaluation method that respects the game model established by each team is required.
In this context, the DEA analysis is confirmed as a valid methodology, and imposes no importance, or weight range preset on the inputs or the products. And besides, does not impose a specific function of the relationship between inputs and outcomes.
This analysis technique is frequently used to evaluate the efficiency of a producer. The producers are known within the DEA literature as decision units or DMUs, for its acronym (Decision Making Units). The evaluation of a decision unit is done by comparing a particular unit with the performance of similar units that provide the same service.
DEA can compare a DMU directly with a similar or a combination identifying those that require more attention and indicating where improvements can be made. That is, this analysis not only allows teams to asses adapting to his own pattern of game, but also points the tactical aspects that require improvement.

Thanks to these and other advantages, the DEA initiated by Charnes, Cooper and Rhodes (1978) has been increasingly applied in different fields. It should be noted that until 2007 there were more than 4000 research papers in journals and book chapters on this theme.
Applications of DEA in the sport are varied, such as the creation of rankings in competitions where exploiting the flexibility of the DEA to change the weights for each position in the classification to make it more appropriate (Soares de Mello, Angulo-Meza, Lacerda & Biondi, 2009).
Other studies aim to assess the performance in team sports, either to estimate the performance of the team or individual players. DEA has been used for assessing the overall efficiency of a team in a season or of different players taking into account the nature of the game (Cooper, Ruíz & Sirvent, 2009; Fried, Lambrinos & Tyner, 2004).
The aim of this paper was to assess the efficiency of national handball teams in the senior male category by applying the DEA.

METHOD

In order to study, data were obtained from the participating teams in the Men's World Handball Championships 2011 held in Sweden, therefore, the sample analyzed in this article are the 24 teams in the championship. The data used came from official statistics of the International Handball Federation (IHF).
In this study the statistics of goals and shots from different distances, situations and positions for the game has been considered. Likewise, other aspects such as goals from counterattacks, recoveries and blocks were also rated. Specifically, 8 variables have been used in the analysis and are described below: "Gwing" goals achieved from the wing position, "G6m" are the goals scored from 6 meters, "G9m" goals achieved from 9 meters, "G7m" the goals scored from 7 meters, "Gfastb" goals obtained by counterattack, "gbt" goals obtained by breakthrough, "Rec", recoveries made and "Bloc", the blocks made.
The application of DEA to these variables allowed the classification of teams as efficient and inefficient, and to establish the patterns of game used by each team. Thus, knowing the patterns of play of each team and the efficiency level of each of the different variables studied facilitates an analysis of the characteristics of participants of the Men's World Handball Championship of 2011.
The index of relative efficiency provided by the DEA agglutinates into a single value the efficiency data obtained in the different variables. To obtain this index the following formula is applied:

$$I=\omega_1 \times G9m+\omega_2 \times G6m+\omega_3 \times G7m+\omega_4 \times Gwing+\omega_5 \times Gfastb+\omega_6 \times Gbt+\omega_7 \times Rec+\omega_8 \times Bloc.$$

Thus, a team is efficient if and only if, its efficiency ratio is equal to 1, otherwise it is inefficient, and the lower your score is lower efficiency. The DEA benchmarking analysis has been complemented with a cross-efficiency evaluation, which provides a peer-evaluation of the players that makes it possible to rank them.
It is worth emphasizing that DEA allows a complete liberty of choice of weights: if a team is free to choose their pattern of game (and therefore the weights of the different variables) and other teams have a greater efficiency score on those weights, then the statement of inefficiency is reinforced as it is not based on imposing a predetermined model.
The coordination of these reference models allows to study the directions of improvement of inefficient teams, being them a useful tool to improve teams game.

DEVELOPMENT

DEA revealed that 9 teams out of 24 teams participating were efficient (Table 1). In the assessment of each team, DEA respects its characteristics in the sense that these are allowed to choose weights that are team-specific, which means that the relative importance attached to the variables involved may vary from team to team. So the contributions to the efficiency of every aspect of the game for each team were registered.

Table 1. Efficient teams and relative contribution of the game variables analyzed.

	N	G6m	Gwing	G9m	G7m	Gfastb	Gbt	Rec	Bloc	Total
FRANCE	13	11,04%	11,04%	11,04%	13,38%	13,38%	13,38%	13,38%	13,38%	100,00%
DENMARK	9	22,79%	22,79%	22,79%	6,32%	6,32%	6,32%	6,32%	6,32%	100,00%
SPAIN	13	6,32%	14,40%	6,32%	26,99%	6,32%	6,32%	26,99%	6,32%	100,00%
CROATIA	2	5,28%	23,80%	5,28%	24,90%	5,28%	24,90%	5,28%	5,28%	100,00%
ICELAND	5	3,13%	3,13%	3,13%	3,13%	40,61%	3,13%	40,61%	3,13%	100,00%
HUNGARY	0	1,95%	1,95%	1,95%	35,42%	48,64%	1,95%	1,95%	6,18%	100,00%
NORWAY	6	68,03%	1,80%	1,80%	1,80%	1,80%	1,80%	1,80%	21,17%	100,00%
KOREA	0	6,64%	1,18%	1,18%	54,79%	1,18%	32,65%	1,18%	1,18%	100,00%
SLOVAKIA	4	34,46%	8,43%	4,75%	33,39%	4,75%	4,75%	4,75%	4,75%	100,00%

The contributions are the product of the weights obtained and the actual data. The contributions to the efficiency represent the contribution of each factor to the overall efficiency. Therefore, provide information on the importance of each aspect of the game has to evaluate each team.

Thus, the existence of highly specialized teams that achieve efficiency by putting all the weight on a single aspect has been revealed. In contrast, other teams have more balanced patterns in which all the different aspects of the game have a more distributed weight.

Many times the validity of a strategic or tactical approach of a team is based solely on the achievement of the victory, being the winner rated as the best. But this idea should not blind us to assess the efficiency of other participants, as has been shown that there may be other teams that can serve as a model of efficiency.

DEA also incates the number of times each efficient equipment has acted as a reference in the evaluation of other teams. This data shows which teams have played an important role in the analysis of relative efficiency. There are teams that have acted as a reference multiple times, and others not.

DEA shows the directions of improvement for inefficient teams (Table 2) by comparing the real data of each team and their coordinates of efficiency. The directions of improvement, expressed in percentages, facilitates recognize those teams that are almost efficient and those wich should improve many aspects of their game.

Table 2. Directions for improvement of inefficient teams.

	G6m	Gwing	G9m	G7m	Gfastb	Gbt	Rec	Bloc
SWEDEN	40,37%	17,35%	22,83%	47,87%	17,35%	17,35%	17,35%	42,90%
POLAND	4,22%	18,83%	24,74%	12,66%	4,22%	17,15%	4,22%	4,22%
SERBIA	42,76%	9,82%	9,82%	9,82%	82,63%	9,82%	89,11%	32,12%
GERMANY	1,44%	1,44%	1,44%	46,71%	50,75%	14,14%	1,44%	28,77%
ARGENTINA	40,29%	18,24%	88,04%	18,24%	18,24%	18,24%	21,86%	34,05%
EGYPT	35,74%	23,61%	96,99%	34,06%	58,75%	34,30%	23,61%	39,53%
ALGERIA	48,53%	48,53%	48,53%	336,20%	90,39%	48,53%	48,53%	74,15%
JAPAN	66,69%	5,21%	191,49%	129,84%	5,21%	5,21%	37,79%	229,42%
AUSTRIA	0,14%	48,71%	12,65%	29,53%	0,14%	101,51%	31,28%	0,14%
ROMANIA	35,85%	16,31%	16,18%	17,66%	18,22%	67,84%	5,81%	5,81%
TUNISIA	33,45%	33,45%	39,30%	102,06%	91,19%	33,45%	33,45%	33,45%
BRAZIL	1,34%	1,34%	68,12%	1,34%	53,15%	14,31%	9,60%	11,05%

CHILE	50,55%	28,40%	110,76%	135,47%	15,30%	10,09%	10,09%	54,59%
BAHRAIN	96,04%	155,65%	62,75%	40,57%	26,82%	26,82%	26,82%	138,33%
AUSTRALIA	87,42%	176,56%	87,42%	87,42%	161,13%	87,42%	107,65%	152,38%

Note that these directions of improvement have been selected taking into account the pattern of the game of each team and not to copy a fixed model or the game model of another team. The directions of improvement are team-specific.
Finally, a cross-efficiency evaluation was applied in order to obtain a ranking of efficiency. A comparison was made between the classification achieved by each team in the World Championship and this ranking. With few exceptions, both classifications are very similar.

CONCLUSIONS

DEA can be a powerful tool for coaches. Recognize different efficiency models can ease the task of the coach in selecting wich aspects of the game improve. The election of a plausible model of efficiency can lead to greater levels of efficiency, and therefore high levels of performance.
The index of relative efficiency provided by the DEA agglutinates into a single value the efficiency data obtained in the different variables. As stated earlier, DEA imposes no specific pattern of game, respecting the game model defined by each team. Therefore, each team can exploit their strengths in the assessments. For that purpose, patterns of game of inefficient teams are established based on the modeling weights of efficient teams.
DEA can identify directions for improvement. Coaches with information on the strengths and weaknesses of their team can implement development plans that will lead their teams to success.

PROPOSAL FOR COACHES

DEA can be applied in different situations: Late season: To recognize weaknesses and select correctly the players needed to reinforce the team; during the season, to correct the errors and to establish which tactical aspects should be prioritized to improve the team; before a new competition: with an adequate amount of matches in other competitions, DEA can be used to determine the status of the team.

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