Observational Analysis of the Construction of Sequences That end in a Shot in U14 Basketball According to the Players' Position

Análisis Observacional de la Construcción de las Secuencias que Acaban en Lanzamiento en Baloncesto Sub-14 en Función de la Demarcación de los Jugadores

Mario Amatria[1]
Rubén Arroyo[1, 2]
Javier Arana[3]
Daniel Lapresa[3]

[1] Department of Physical Education and Sport, Pontifical University of Salamanca, Spain
[2] Department of Education in Sciences, University of Burgos, Spain
[3] Department of Educational Sciences, University of La Rioja, Spain

Correspondence:
Daniel Lapresa
daniel.lapresa@unirioja.es

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Abstract

Using observational methodology, a study was carried out on the offensive sequences that end in a shot—both effective and ineffective—for FC Barcelona's elite U14 team, champions of the Minicopa Endesa 2020. An observation instrument was adapted from one with proven validity. The data was recorded using the free software Lince. The observational sample is composed of all the sequences that end in a shot. The reliability of the recordings was guaranteed by inter-observer agreement using Cohen's kappa coefficient. Complementary use of the decision tree analysis technique and the detection of T-patterns —using the software Theme— made it possible to characterise the construction of the sequences that end in shots that were both effective and ineffective. It may be concluded that in the elite U14 category, ineffective sequences still predominate over effective ones, except for the inside shots of players in a point guard position

Keywords: Match analysis, U14 basketball, efficiency, tree analysis technique, T-patterns.

Resumen

En el seno de la metodología observacional se ha realizado un estudio de las secuencias ofensivas que acaban en lanzamiento -eficaces e ineficaces- de un equipo de élite de la categoría sub-14: el FC Barcelona, campeón de la "Minicopa Endesa 2020". Se ha realizado una adaptación de un instrumento de observación que cuenta con probadas evidencias de validez. El registro de los datos se ha realizado mediante el programa libre Lince. El muestreo observacional está compuesto por la totalidad de las secuencias que finalizan en lanzamiento. Se ha garantizado la fiabilidad de los registros, mediante concordancia inter-observadores, a través del coeficiente Kappa de Cohen. La utilización de forma complementaria de la técnica de análisis de árboles de decisión y de la detección de T-patterns -mediante el software Theme- han permitido caracterizar la construcción de las secuencias que acaban en lanzamiento -eficaces e ineficaces-. Se concluye que en la élite de la categoría sub 14 todavía predominan las secuencias ineficaces sobre las eficaces, salvo en los lanzamientos interiores del jugador con demarcación base.

Palabras clave: Match analysis, baloncesto sub-14, eficacia, árboles de decisión, T-patterns.

Introduction

This paper studies the offensive sequences that end in a shot —both effective and ineffective— of FC Barcelona's U14 team, champion of the Minicopa Endesa 2020. The Minicopa is a competition in which the youth teams of the eight teams that have qualified for the Copa del Rey de Baloncesto (ACB) take part. To highlight the importance and relevance of this youth competition, it is worth noting that it takes place at the same time as the Copa del Rey (ACB) and in the same location.

Analyses of efficiency are common in elite basketball (Alsasua et al., 2019; Sampaio et al., 2010). The most common performance indicator in this field is shot success (Erculj & Strumbelj, 2015), which is analysed in a wide range of contexts: comparisons between winning and losing teams (Fernández & Piñar, 2017), home and away (Ribeiro et al., 2016) and league and play-off games (Nunes et al., 2022).

However, to better understand what happens during a basketball game, it is important to analyse not only how and where shots are taken, but the actions leading to said shots (Fernández et al., 2009; Romarís et al., 2012). That is why, in order to define basketball performance, the analysis of offensive sequences that end in a shot is particularly important (Fernández & Piñar, 2017; Kubatko at al., 2007; Ozakaki & Rodacki, 2012; Sampaio et al., 2010).

Although the study of effectiveness in team sports —and specifically in basketball— has traditionally been based on a series of indicators related to frequencies or occurrences, this type of data is insufficient to address the complexity of sport interrelationships in a sport as complex as the one in question (Alsasua et al., 2018; Serna et al., 2022). By contrast, match analyses carried out as part of the observational methodology allow for rigorous diachronic analyses that make possible to detect the underlying structure from the dataset collected during time and using intrasessional following (Anguera et al., 2020; Anguera et al., 2021).

Regarding basketball training games, as the age category increases so does the structuring and systematization of the game (Piñar et al., 2014). The younger the players are, the more their basketball playing is characterized by a minimally sophisticated collective game with a larger number of counterattacks (Ortega et al., 2006), lesser use and efficiency in external shots (Lorenzo et al., 2010), and most shots taken close to the basket (Monteiro et al., 2013).

The aim of this article is to characterise the construction of sequences that end in a shot —both effective and ineffective— of FC Barcelona's U14 team, champion of the Minicopa Endesa 2020, with the innovative contribution of taking into account the position of the players who perform the shot. Meeting this objective will contribute to generating relevant information that can be taken into consideration by trainers in youth basketball for the U14 age group.

Method

In this study observational methodology was used (Anguera, 1979). According to Anguera et al. (2011) the observational design is: idiographic —the champion team—; intersessional follow-up —performance in all the matches of the Minicopa Endesa 2020, the championship under study— and intrasessional follow-up —which enables diachronic analyses of behaviour—; and multidimensional, with proxemic and gestural dimensions.

Participants

According to Otzen and Manterola (2017), purposive sampling was carried out for the FC Barcelona team in the Minicopa Endesa 2020 tournament. This championship pits the best national teams in the youth category (players aged 13 and 14) against each other. From the detailed information on the championship website (https://www.acb.com/articulo/ver/152559-plantillas-minicopa-endesa-malaga-2020.html), the FC Barcelona squad is made up of point guards —players with numbers 4, 11 and 13—, small forwards —players 1, 2, 3, 5, 6, 7 and 12—, and power forwards —players 8, 9, 10, 14 and 15—.

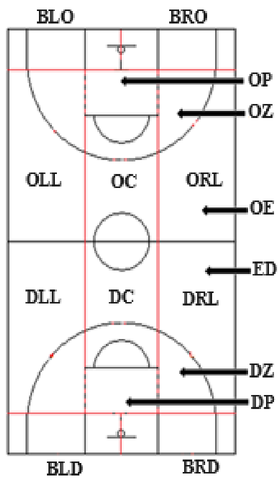
This study obtained the approval of the Ethics Committee of the University of La Rioja (file CE_56_2023) as it complies with the guidelines established by the Belmont Report and the Declaration of Helsinki.

Observation Instrument

An adaptation was made of the observation instrument proposed by Alsasua et al. (2018), based on the SOB2 of Fernández et al. (2009). The adaptation (see table 1) consisted of the addition of two new dimensions —player and position— which will allow us to meet the study aim with a greater degree of certainty.

This observation instrument is a combination of field format and category systems —exhaustive and mutually exclusive—.

Table 1
Observation instrument

n	Criterion	Categories: codes and short description	Basketball court
1	Start of the game	Ball in play (BP); defensive bottom throw-in (DBT); defensive throw-in (DT); initial jump (IJ); offensive bottom throw-in (OBT); offensive throw-in (OT); free shot (FS).	
2	Laterality	Offensive right lateral (ORL); bottom right offensive (BRO); offensive centre (OC); offensive left lateral (OLL); bottom left offensive (BLO); defensive right lateral (DRL); bottom right defensive (BRD); defensive centre (DC); defensive left lateral (DLL); bottom left defensive (BLD).	
3	Area	Offensive exterior (OE); offensive zone (OZ); offensive paint (OP); defensive exterior (DE); defensive zone (DZ); defensive paint (DP).	
4	Game Action	Ball recovered (BR); offensive rebound (OR); defensive rebound (DR); penultimate pass (P1); reception 1 (R1); last pass (P2); reception 2 (R2); completion (C1); rebound and offensive pass (ROP); rebound and penultimate offensive pass (RP1OP); rebound and last offensive pass (ROP2); rebound and defensive pass (RDP); rebound and penultimate defensive pass (RP1DP); rebound and last defensive pass (RDP2).	
5	Type of completion	Favourable (fav): Score (SC); received foul (RF); score and foul (A1). Unfavourable (unfav): Miss (MS); foul given (FG); violation (VI); block (BL).	
6	Player	Player 1 (P1); player 2 (P2); player 3 (P3); player 4 (P4); player 5 (P5); player 6 (P6); player 7 (P7); player 8 (P8); player 9 (P9); player 10 (P10); player 11 (P11); player 12 (P12); player 13 (P13); player 14 (P14); player 15 (P15).	
7	Positions	Point guard (PG); small forward (SF); power forward (PF); centre (C); shooting guard (SG).	

Procedure

The data was recorded using the free software Lince, version 1.4. (Gabin et al., 2012) (see Figure 1). The data obtained are type IV, time-based and concurrent, according to Bakeman's (1978) classic classification for observational data. The 441 sequences in which FC Barcelona achieved a shot throughout the competition were recorded (table 2); in total 2134 multi-events were recorded (Bakeman & Quera, 2011). Each sequence comprised the shot itself and a maximum of five actions immediately preceding the shot (maximum of six rows for each sequence in the dataset).

Figure 1
Screenshot from recording using Lince, version 1.4.

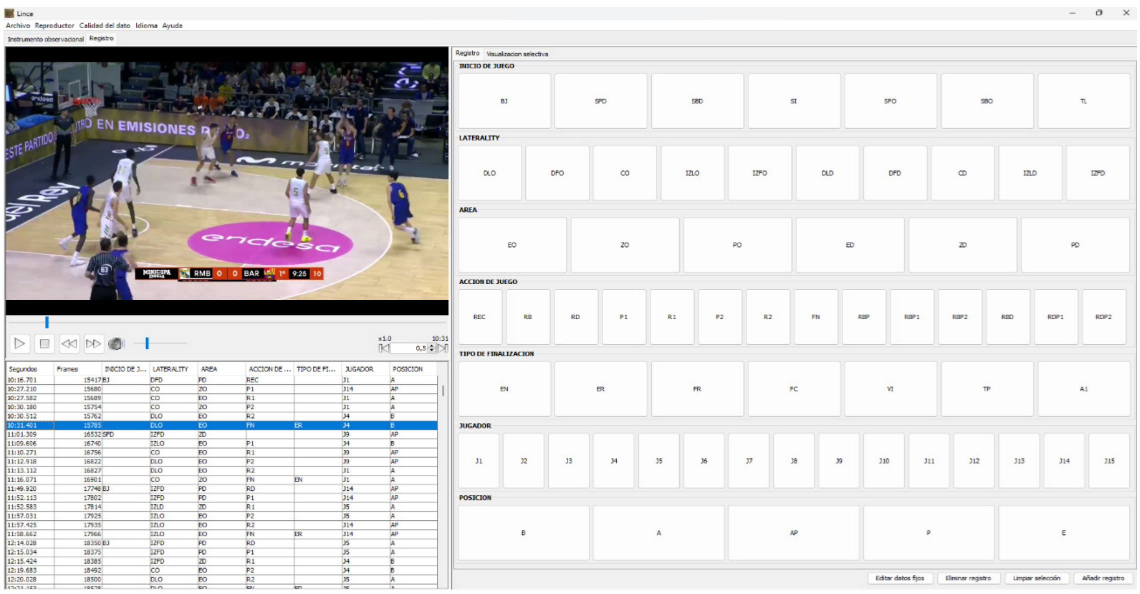


Table 2
Games analysed, cumulative sequences and number of multi-events recorded

Phase	Date	Rival	Result	Sequences	Cumulative sequences	Registered multi-events
Groups	12/02/20	Cajasiete Canarias	48 – 76	97	1-97	490
Groups	13/02/20	Joventut Badalona	50 – 84	82	98-179	392
Groups	14/02/20	Valencia Basket	46 – 76	83	180-262	388
Semifinal	15/02/20	Coosur Real Betis	71 – 72	96	263-358	446
Final	16/02/20	Real Madrid	65 – 67	83	359-441	418

Data Quality Control

Data recording was carried out by two expert observers –university professors responsible for the subject of Basketball, with considerable experience in observational methodology– who followed a training process based on Anguera (2003). Both observers recorded all the sequences that make up the observational sample.

The reliability of the data packages was ensured by inter-observer agreement using Cohen's kappa coefficient (1960). This coefficient was calculated using GSEQ software, version 5.1 (Bakeman & Quera, 2011). The inter-observer concordance score was higher than .83 in all the games included in the study (Cajasiete = .91; Joventut Badalona = .84; Valencia Basket = .83; Coosur Real Betis = .88; Real Madrid = .84). According to the classic reference values of Landis and Koch (1977), the consideration of agreement is almost perfect.

In terms of categories, "Positions" is made up of the positions reflected on the Championship website. In the relationship provided to the tournament organisation by FC Barcelona of the five categories that make up this criterium, three were the positions: point guard, small forward and power forward. To guarantee the reliability of the categorisation used, the position assigned to each player was subjected to the consideration of both observers –separately and at the end of the complete record of the observational sample–. Agreement was verified between the relationship published on the championship website with that carried out by both observers.

Data Analysis

The Two analytical techniques were used to meet the objective set out in this study: one of a synchronic nature –which doesn't adhere to the structure of the intrasessional sample carried out– and the other diachronic –from the structure of the record generated during the intrasessional follow-up (Anguera et al., 2021)–.

Firstly, the decision tree technique was used. Its widespread application in different areas and backing in the literature make it a prominent tool for classification and prognosis (Lee et al., 2022). Decision tree analysis is an analytical method widely used in the field of data mining, creating a tree-based classification model that classifies cases or predicts values of a consequent dimension based on the categories or values of antecedent dimensions (Yang & Zhou, 2020). In particular, it is a technique that can be useful for three interlinked analyses. Firstly, it facilitates the search for the best associations of the antecedent dimensions with the consequent dimension. Secondly, it allows us to discover which categories or values of an antecedent dimension are homogeneous in relation to the consequent dimension. And, finally, it is an appropriate technique for detecting interactions between antecedent dimensions (Berlanga et al., 2013; Escobar, 2007).

In the context of decision trees, it is possible to distinguish between classification and regression trees, the difference being determined by the nature of the consequent dimension. If the dimension is qualitative, they are called classification trees, while if it is quantitative, they are classified as regression trees. In this analysis, the classification tree has been chosen, as the consequent dimension of 'shot result' is of a categorical nature.

A variety of statistical algorithms, such as CHAID (Chi-square Automatic Interaction Detector), CRT (Classification and Regression Trees) and QUEST (Quick, Unbiased, Efficient and Statistical Tree), among others, are available for the construction of decision trees, offering fast and efficient options for data mining (Shamrat et al., 2022; Song & Ying, 2015). In this study, the CRT algorithm was used to generate a classification tree, chosen for its effectiveness as a case classifier, achieving maximum intra-group homogeneity and maximum inter-group heterogeneity (Escobar, 2007). Furthermore, it has the valuable feature of automatically grouping large categorical variables into a few categories (Sharma & Kumar, 2016).

The construction of the CRT classification tree is based on binary splitting, using the Gini index as a measure to select the splitting attribute. This process continues until the data can no longer be separated, allowing the formation of a structured tree (Arabfard et al., 2023; Milani et al., 2020; Sharma & Kumar, 2016). For this purpose, IBM SPSS Statistics 28.0 software was used.

Initially, level filters restrict the development of the tree in terms of depth by limiting the number of levels below the root node (node 0), which represents the consequent dimension, in our case, the 'type of completion'. In this context, it is important to note that the automatic adjustment of the SPSS programme limits the tree to five levels for the CRT growth method (Berlanga et al., 2013). Secondly, size filters regulate the expansion of the trees by limiting the number of frequencies in the tree segments or nodes, both parent (internal) and branch (leaf or terminal). In this research, the recommended rule of thumb was followed: 100 cases for internal nodes and 50 cases for terminal nodes (Escobar, 2007). Thirdly, the Gini index was used as a metric to assess the impurity of the split nodes, seeking to maximise the homogeneity of the secondary nodes. This index summarises the purity or impurity of a specific group in relation to the consequent dimension, with it being a determining factor in allowing or avoiding further segmentations (Escobar, 2007; Yang & Zhou, 2020). It should be noted that this algorithm does not allow for further segmentations unless a set minimum rate of improvement is exceeded, the default value in the SPSS programme being 0.001 for a minimum change in improvement. Finally, the analysis concludes by assessing the predictive accuracy of the segmentation as a whole, representing the goodness-of-fit of the model's performance, through estimation of risk of classificatory ability (Berlanga et al., 2013).

In the second type of analysis used —diachronic analysis— we searched for regular behavioural structures, T-patterns, using THEME 6 Edu software (Anguera et al., 2023; Magnusson, 2000). Although the main contribution of THEME is the detection of temporal patterns, the software also offers the possibility of detecting sequential structures according to the parameter of order —based on a constant duration assigned to each behaviour unit (1 in this study)— which provides very significant possibilities for the analysis of sequentiality, since it allows us to deduce whether the behaviours are consecutive or whether there are gaps in the T-pattern (interspersed behaviours) between the detected multi-events (Lapresa et al., 2013).

According to the reference manual (PatternVision Ltd & Noldus Information Technology bv, 2004) the Free Pattern option was selected, whereby the detection of critical interval relationships occurs by raising the lower limit of the critical interval until a significant relationship is found. In addition, the following search parameters were set:

- A minimum number of occurrences equal to or greater than three.
- Significance level of .005; this significance level has been set by reducing the probability of accepting a critical interval due to chance to .5%.
- Redundancy reduction, so that if more than 90% of the occurrences of a newly detected pattern start and end in the critical interval of the already detected patterns, the new pattern is discarded.

Subsequently, qualitative filters were applied (Amatria et al., 2017), selecting T-patterns that incorporate the 'type of completion' multi-event, and whose internal intervals between multi-events are equal to 1 or 2, then grouping them according to the position of the players and by sequences that end with a shot, whose result is favourable or unfavourable.

Results

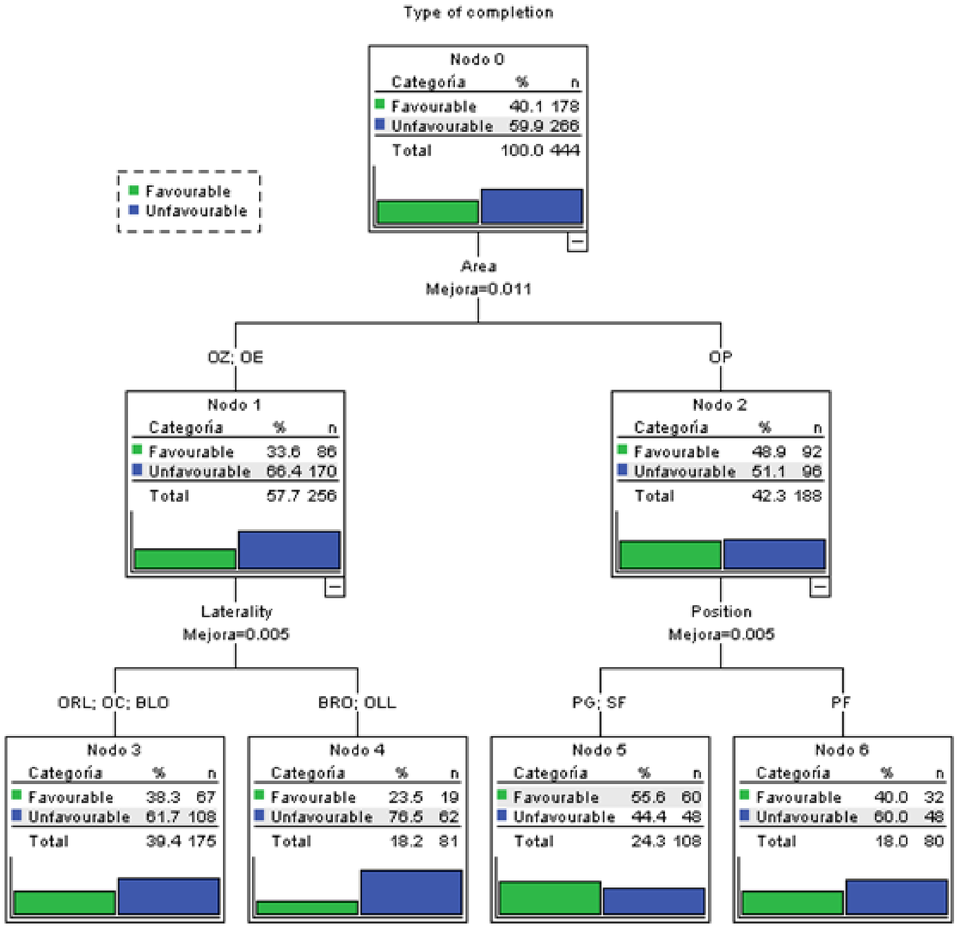
The results of the classification tree are shown in figure 2. The final tree structure includes four division dimensions: 'type of completion, 'area', 'laterality' and 'player position'. In short, it is a classification tree with two levels of depth and seven nodes, four of which are terminal (nodes 3, 4, 5 and 6).

The analysis of the obtained decision tree reveals, firstly, that the most influential dimension in the prediction of 'type of completion' is 'area', followed by the dimensions 'position' and 'laterality'. Moreover, a significant double interaction was identified. In relation to the first association, a connection was made between the dimensions 'area' and 'laterality'. This interaction classifies, on the one hand, that the shots with the highest probability of obtaining an unfavourable result (76.5%) belong to the group of shots taken from the side —'bottom right offensive' (BRO) and 'offensive left lateral' (OLL)— if they have been taken from the areas 'offensive zone' (OZ) and from the 'offensive exterior' (OE) (node 4). Moreover, this failure rate is reduced (61.7%) for shots made from the 'offensive right lateral' (ORL) and 'offensive left lateral' (OLL) if the shots were made from the same areas (node 3).

As for the second interaction, an association was identified between the dimensions 'area' and 'position'. This association classifies that 44.4% of the shots with the lowest probability of obtaining an unfavourable result in the shot belong to the group of shots made by both the point guard (PG) and the small forward (SF), if they were made from the 'offensive paint' (OP) (node 5). On the other hand, the failure rate increases (60.0%) for shots taken by the power forward (PF), from this same area (node 6).

In terms of goodness-of-fit, it was found that the CART algorithm correctly classifies 62.6% of the shots. Specifically, for the category of shots with unfavourable results from the subsequent dimension, it shows a higher scoring rate (82.0%) than for the category of shots with favourable results (33.7%).

Figure 2
Graphic illustration of the decision tree



Note: BLO= bottom left offensive; BRO= bottom right offensive; OC= offensive centre; OE= offensive exterior; OLL= offensive left lateral; OP= offensive paint; ORL= offensive right lateral; OZ= offensive zone; PF= power forward; PG= point guard; SF= small forward.

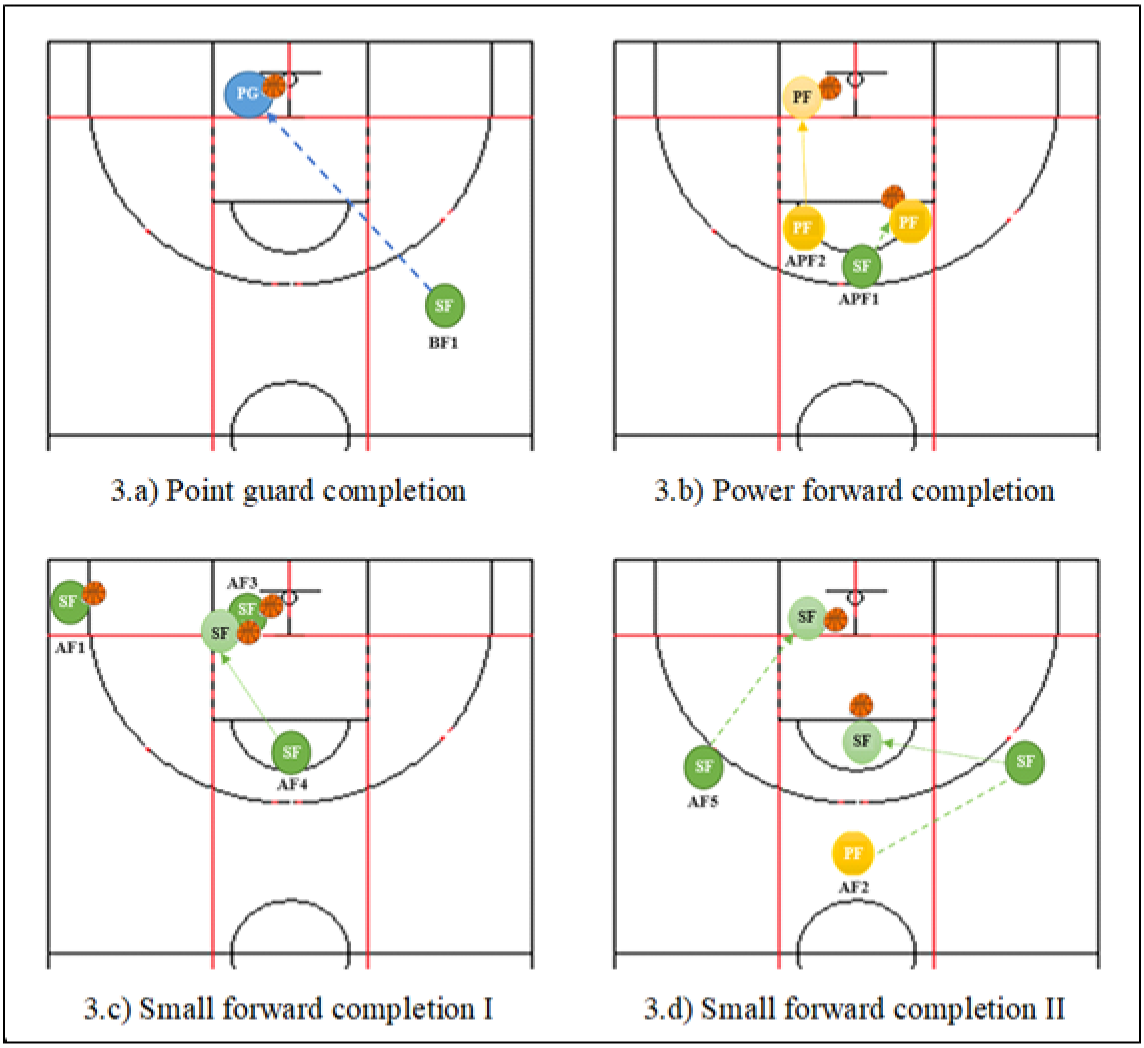
With regard to the T-patterns that were detected by applying the pre-set search parameters, qualitative filters were applied both for their selection and for their grouping. First, we present the T-patterns whose constitutive multi-events reflect sequences that achieve shots with a favourable result (table 3); because of their relevance, we added a graphic illustration of the information contained in these T-patterns, showing shots with a favourable result (figure 3). Next, we present those T-Patterns related to sequences that achieve a shot with a unfavourable result (table 4) and, finally, identified T-Patterns that reflect the same game situations in which both favourable and unfavourable results were achieved (table 5).

Table 3
Identified T-patterns (identifier, string format, occurrences, constitutive multi-events and the mean of their internal intervals) that reflect offensive sequences ending with a favourable result

ID	T-Pattern	Occurrences, multi-events	Mean of the internal intervals
BF1	(orl,oe,p2,sf blo,op,c1,fav,pg)	*n* = 3, length = 2	2
AF1	(blo,oe,r2,a blo,oe,c1,fav,sf)	*n* = 4, length = 2	1
AF2	((oc,oe,r1,pf orl,oe,r2,sf) oc,oz,c1,fav,sf)	*n* = 3, length = 3	2; 1
AF3	(bp,blo,op,or,sf blo,op,c1,fav,sf)	*n* = 3, length = 2	1
AF4	(oc,oz,r2,sf izfo,op,c1,fav,sf)	*n* = 3, length = 2	1
AF5	(oll,oe,p2,sf blo,op,c1,fav,sf)	*n* = 3, length = 2	2
APF1	(oc,oz,p2,sf oc,oz,c1,fav,pf)	*n* = 3, length = 2	2
APF2	(oc,oz,r2,pf blo,op,c1,fav,pf)	*n* = 3, length = 2	1

Figure 3

Graphic illustration of T-Patterns whose favourable result constitution does not coincide with T-Patterns whose constitution ends with an unfavourable result



Note: = non-consecutive action -I.I. = 2-; = consecutive action -I.I. = 1- ;
PG = Point guard; SF = Small forward; PF = Power forward; = Basket.

Table 4

Identified T-patterns (identifier, string format, occurrences, constitutive multi-events and the mean of their internal intervals) that reflect offensive sequences ending with a shot with an unfavourable result

ID	T-Pattern	Occurrences, multi-events	Mean of the internal intervals
BD1	(oll,oe,r2,pg oc,oz,c1,unfav,pg)	*n* =5, length = 2	1
BD2	(oll,oe,r2,pg oll,oz,c1,unfav,pg)	*n* = 4, length = 2	1
BD3	(oc,oe,r2,pg oc,oe,c1,unfav,pg)	*n* = 3, length = 2	1
BD4	(oll,oe,r2,pg blo,oz,c1,unfav,pg)	*n* = 3, length = 2	1
BD5	(orl,oe,r2,pg oc,oz,c1,unfav,pg)	*n* = 3, length = 2	1
AD1	(oc,oz,r2,sf oc,oz,c1,unfav,sf)	*n* = 5, length = 2	1
AD2	(oc,oz,p2,sf oc,oz,c1,unfav,sf)	*n* = 4, length = 2	2
AD3	(orl,oe,r2,sf bro,oz,c1,unfav,sf)	*n* = 4, length = 2	1

AD4	(oc,oe,r2,sf bro,op,c1,unfav,sf)	*n* = 3, length = 2	1
AD5	(bro,oe,r2,sf bro,oe,c1,unfav,sf)	*n* = 3, length = 2	1
AD6	(oll,oe,r2,sf oc,oz,c1,unfav,sf)	*n* = 3, length = 2	1
AD7	(oll,oe,r2,sf blo,oz,c1,unfav,sf)	*n* = 3, length = 2	1
APD1	(bro,oz,r2,pf bro,op,c1,unfav,pf)	*n* = 7, length = 2	1
APD2	(orl,oe,r1,sf (orl,oe,p2,sf bro,op,c1,unfav,pf))	*n* = 6, length = 3	1; 2
APD3	(bro,op,r2,pf bro,op,c1,unfav,pf)	*n* = 6, length = 2	1
APD4	(bro,oz,r2,pf bro,oz,c1,unfav,pf)	*n* = 6, length = 2	1
APD6	(oll,oe,p2,sf bro,op,c1,unfav,pf)	*n* = 6, length = 2	2
APD6	(blo,op,r2,pf blo,op,c1,unfav,pf)	*n* = 6, length = 2	1
APD7	(blo,oz,r2,pf blo,op,c1,unfav,pf)	*n* = 6, length = 2	1
APD8	(bp,bro,op,or,pf bro,op,c1,unfav,pf)	*n* = 5, length = 2	1
APD9	(oll,oe,p1,pg (orl,oe,r1,sf (orl,oe,p2,sf bro,op,c1,unfav,pf)))	*n* = 3, length = 4	1; 1; 2
APD10	(orl,oe,r1,sf (orl,oe,p2,sf (bro,oz,r2,pf bro,op,c1,unfav,pf)))	*n* = 4, length = 4	1; 1; 1
APD11	(oc,oz,p2,sf bro,op,c1,unfav,pf)	*n* = 4, length = 2	2
APD12	((oll,oe,p2,sf blo,oz,r2,pf) blo,oz,c1,unfav,pf)	*n* = 3, length = 3	1;1
APD13	((oll,oe,r1,sf blo,oz,r2,pf) blo,oz,c1,unfav,pf)	*n* = 3, length = 3	2;1
APD14	((obt,bro,oz,p2,pg bro,oz,r2,pf) bro,oz,c1,unfav,pf)	*n* = 3, length = 3	1; 1
APD15	(oc,oz,p2,sf (bro,op,r2,pf bro,op,c1,unfav,pf))	*n* = 3, length = 3	1; 1
APD16	(oc,oz,p2,sf blo,oz,c1,unfav,pf)	*n* = 3, length = 2	2
APD17	(orl,oe,p2,sf bro,op,c1,unfav,pf)	*n* = 3, length = 2	2
APD18	(oll,oe,r2,pf oll,oe,c1,unfav,pf)	*n* = 3, length = 2	1

Table 5
Identified T-patterns (identifier, string format, occurrences, constitutive multi-events and the mean of their internal intervals) that reflect the same offensive sequences that obtain shots with both favourable and unfavourable results

ID	T-Pattern	Occurrences, multi-events	Mean of the internal intervals
BFD1	(oll,oe,r2,pg oll,oe,c1,fav,pg)	*n* = 5, length = 2	1
	(oll,oe,r2,pg oll,oe,c1,unfav,pg)	*n* = 13, length= 2	1
BFD2	(orl,oe,r2,pg orl,oe,c1,fav,pg)	*n* = 4, length = 2	1
	(orl,oe,r2,pg orl,oe,c1,unfav,pg)	*n* = 7, length = 2	1
BFD3	(bro,oe,r2,pg bro,oe,c1,fav,pg)	*n* = 3, length = 2	1
	(bro,oe,r2,pg bro,oe,c1,unfav,pg)	*n* = 3, length = 2	1
AFD1	(oll,oe,r2,sf oll,oe,c1,fav,sf)	*n* = 9, length = 2	1
	(oll,oe,r2,sf oll,oe,c1,unfav,sf)	*n* = 14, length = 2	1
AFD2	(orl,oe,r2,sf orl,oe,c1,fav,sf)	*n* = 6, length = 2	1
	(orl,oe,r2,sf orl,oe,c1,unfav,sf)	*n* = 12, length = 2	1
AFD3	(orl,oe,r2,sf oc,oz,c1,fav,sf)	*n* = 4, length = 2	1
	(orl,oe,r2,sf oc,oz,c1,unfav,sf)	*n* = 8, length = 2	1
AFD4	(oc,oe,r2,sf oc,oz,c1,fav,sf)	*n* = 4, length = 2	1
	(oc,oe,r2,sf oc,oz,c1,unfav,sf)	*n* = 6, length = 2	1
AFD5	(oc,oe,r2,sf oc,oe,c1,fav,sf)	*n* = 4, length = 2	1
	(oc,oe,r2,sf oc,oe,c1,unfav,sf)	*n* = 5, length = 2	1
AFD9	(oll,oe,r2,sf blo,op,c1,fav,sf)	*n* = 3, length = 2	1
	(oll,oe,r2,sf blo,op,c1,unfav,sf)	*n* = 4, length = 2	1

AFD10	(bp,bro,op,or,sf bro,op,c1,fav,sf)	*n* = 4, length = 2	1
	(bp,bro,op,or,sf bro,op,c1,unfav,sf)	*n* = 3, length = 2	1
AFD13	(blo,op,r2,sf blo,op,c1,fav,sf)	*n* = 3, length = 2	1
	(blo,op,r2,sf blo,op,c1,unfav,sf)	*n* = 3, length = 2	1
APFD1	(blo,oz,r2,pf blo,oz,c1,fav,pf)	*n* = 4, length = 2	1
	(blo,oz,r2,pf blo,oz,c1,unfav,pf)	*n* = 9, length = 2	1
APFD13	(oc,oz,r2,pf oc,oz,c1,fav,pf)	*n* = 6, length = 2	1
	(oc,oz,r2,pf oc,oz,c1,unfav,pf)	*n* = 4, length = 2	1
APFD14	(oc,oz,r2,pf bro,op,c1,fav,pf)	*n* = 5, length = 2	1
	(oc,oz,r2,pf bro,op,c1,unfav,pf)	*n* = 4, length = 2	1

Discussion

In order to meet the objective of characterising the construction of the sequences that end in a shot —both effective and ineffective— of FC Barcelona's U14 team, champion of the Minicopa Endesa 2020, taking into account the position of the players who perform the shot, two types of analysis were carried out: one synchronous (decision trees) and the other diachronic (detection of T-patterns). Although the true potential of observational methodology is obtained from diachronic analysis with data that incorporate order and/or duration, synchronic statistical analyses which look for association relationships between dimensions that provide categorical data, are also relevant to meet the objectives set out in match analysis (O'Donoghue, 2009).

Firstly, the results obtained using the decision tree technique are discussed. The data reveal a clear predominance of ineffective sequences —shots that have an unfavourable result— with the dimension 'area' having the strongest association with the criterion 'type of completion'. Moreover, a significant increase in the number of sequences achieving a shot with an unfavourable result is observed when the dimensions 'area' and 'laterality' are combined. These results are in line with the lower shot efficiency identified in lower categories —U12 (Alsasua et al., 2018); U14 (Fernández & Piñar, 2017); U16 (Ortega et al., 2007)— in relation to professional basketball (Fernández et al., 2009; Mexas et al., 2005).

As a result of the analysis of the position of the player who makes the shot and the area from where it is made, it can be seen that both the point guard (PG) and the small forward (SF) manage to complete sequences with a favourable result from the offensive paint (OP); while in these types of shots the unfavourable result prevails if they are made by a player in a power forward (PF) position. These completion areas, depending on the position of the player who makes the shot, do not fit in with the traditional game profiles (García et al., 2019) of these positions (point guard: passer and outside scorer; inside players: power forwards and centres, specialists in the game close to the hoop; forwards: intermediate functions); and point to the versatility of play towards which current basketball is moving (Rolland et al., 2020). In relation to efficiency, the results obtained are in line with those obtained in U16 basketball by Alsasua et al. (2018), who found the greatest efficiency in shooting from positions close to the basket.

On the diachronic side, the T-patterns identified using Theme software reflect relevant information on the construction of offensive sequences that achieve shots according to the position of the players. With regard to the player occupying the point guard position, T-patterns were identified that reflect the point guard's shots, with both favourable and unfavourable results, made from the outside: specifically a last ball reception and shot from the sides (offensive left lateral (OLL) —T-patterns with ID BFD1— and offensive right lateral (ORL) —BFD2—) and the back of the court (bottom right offensive (BRO) —BFD3—). These regular behavioural structures reflect the play specialisation of the point guard who, in addition to having the main mission of ordering the team's play (Gómez & Lorenzo, 2007), generates outside shots when the inside game does not have options for positive progress (Romarís et al. 2012). This play situation of taking advantage of outside space after inside play favours successful finishing in elite basketball.

The T-patterns reflecting offensive sequences that end in a shot by the player occupying the small forward position reflect their versatility in the game, both inside and outside (García-Rubio et al., 2019). Looking at the inside game, T-patterns were identified reflecting offensive sequences that achieve favourable completion from the zone (intermediate zone (IZ) —ID AF2—) and offensive paint (OP) —AF4 and AF5— and baskets scored after an offensive rebound (OR) —AF3—. T-patterns were also detected reflecting inside play with shots made by the small forward generating an unfavourable result, both from the zone —AD1, AD2, AD3, AD6 and AD7— and from the paint —AD4—. In reference to the outside play of the forwards, the T-patterns presented reflect offensive sequences that end with both favourable —AF1— and unfavourable results —AFD1, AFD2, AFD5—.

Regarding the player occupying the power forward position, the T-patterns presented —APF1 and APF2— reflect sequences with effective finishing from the paint. The fact that this type of sequence is related to the power forward position highlights the specialisation that this position requires (García-Rubio et al., 2019) in order to take advantage of the greater efficiency that comes with shooting close to the basket (Romarís et al., 2012). T-patterns —APD1, APD2, APD3, APD5, APD6, APD7, APD8, APD9, ADP10, ADP11 and APD17— have also been identified reflecting sequences with shots that achieve an unfavourable result made by power forwards from the offensive paint (OP). These types of sequences, with both favourable and unfavourable results, have also been identified in U16 players (Alsasua et al., 2018) and in elite players (Gómez & Lorenzo, 2007).

Conclusion

The complementary use of the decision tree analysis technique and the detection of T-patterns —through Theme software— have made it possible to characterise the construction of the sequences that end in a shot, both effective and ineffective, of FC Barcelona's U14 team, champion of the Minicopa Endesa 2020, taking into account the position of the players who perform the shot.

It may be concluded that in the elite U14 category there is still a predominance of ineffective sequences —whose shots generate an unfavourable result— over effective ones; this aspect must be optimised during ensuing formative stages, gradually converging on the efficiency shown by elite teams.

Specifically, the player with the position of point guard has a role based on support and construction of offensive action, completing plays from outside areas —with effective and ineffective shots— but also with inside play actions with effective shots close to the hoop. Forwards have more versatile sequences of play, both inside and outside (effective and ineffective). Finally, the power forward position is characterised by its ability to finish close to the basket, although ineffectively.

The limitations and prospects of this work converge in that we are faced with a study that analyses a team's match-play, which can serve as a reference in the building of players who aspire to the Basketball elite in the U14 category. We continue to be interested in shedding light on the evolution of match-play in basketball in relation to age category, in order to offer trainers and coaches relevant information with which to reflect on the training process of their players.

Ethics Committee Statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee: University of La Rioja (file CE_56_2023, date of approval: 13-09-2023).

Conflict of Interest Statement

The authors declare that there are no conflicts of interest. The funding bodies or institutions had no influence on the design of the study, the analysis of the data or the interpretation of the results.

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Authors' Contribution

Conceptualization M.A., R.A., J.A. & D.L.; Methodology M.A., R.A., J.A. & D.L.; Software M.A. & R.A.; Validation M.A., J.A. & D.L.; Formal Analysis M.A., R.A., J.A. & D.L.; Resources M.A. & R.A.; Data Curation M.A. & R.A.; Writing – Original Draft M.A., R.A., J.A. & D.L.; Writing – Review & Editing M.A., R.A., J.A. & D.L.; Visualization M.A., R.A., J.A. & D.L.; Supervision D.L.; Funding Acquisition D.L. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author (daniel.lapresa@unirioja.es).

References

Alsasua, R., Lapresa, D., Arana, J., & Anguera, M.T. (2019). A log-linear analysis of efficiency in elite basketball applied to observational methodology. *International Journal of Sports Science & Coaching*, *14*(3), 363–371. https://doi.org/10.1177/1747954119837819

Alsasua, R., Lapresa, D., Arana, J., Anguera, M.T., & Garzón, B. (2018). Successful and unsuccessful offensive sequences ending in a shot in professional and elite under-16 basketball. *Journal of Human Kinetics, 64*(1), 147-159. https://doi.org/10.1515/hukin-2017-0191

Amatria, M., Lapresa, D., Arana, J., Anguera, M.T., & Jonsson GK. (2017). Detection and selection of behavioral patterns using Theme: a concrete example in grassroots soccer. *Sports, 5*(1) 20. https://doi.org/10.3390/sports5010020

Anguera, M.T. (1979). Observational typology. *Quality & Quantity. European-American Journal of Methodology, 13*, 449-484. https://doi.org/10.1007/BF00222999

Anguera, M.T. (2003). La observación [The observation]. In C. Moreno Rosset (Ed.), *Evaluación psicológica. Concepto, proceso y aplicación en las áreas del desarrollo y de la inteligencia* (pp. 271-308). Sanz y Torres.

Anguera, M.T., Blanco-Villaseñor, A., Hernández-Mendo, A., & Losada, J. (2011). Diseños observacionales: ajuste y aplicación en psicología del deporte. *Cuadernos de Psicología del Deporte, 11*(2), 63-76. https://revistas.um.es/cpd/article/view/133241

Anguera, M.T., Blanco-Villaseñor, A., Losada, J.L., & Sánchez-Algarra, P. (2020). Integración de elementos cualitativos y cuantitativos en metodología observacional [Integration of qualitative and quantitative elements in observational methodology]. Ámbitos. Revista Internacional de Comunicación, (49), 49-70. https://doi.org/10.12795/Ambitos.2020.i49.04

Anguera, M.T., Jonsson, G.K., Escolano-Pérez, E., Sánchez-Lopez, C. R., Losada, J.L., & Portell, M. (2023). T-pattern detection in the scientific literature of this century: A systematic review. *Frontiers in Psychology, 14,* 1085980. https://doi.org/10.3389/fpsyg.2023.1085980

Anguera, M.T., Portell, P., Hernández-Mendo, A., Sánchez-Algarra, P., & Jonsson, G.K. (2021). Diachronic analysis of qualitative data. In A.J. Onwuegbuzie and B. Johnson (Eds.), *Reviewer's Guide for Mixed Methods Research Analysis* (pp. 125-138). Routledge.

Arabfard, M., Najafi, A., & Rezaei, E. (2023). Predicting COVID-19 Models for Death with Three Different Decision Algorithms: Analysis of 600 Hospitalized Patients. *Journal of Applied Biotechnology Reports*, *10*(2), 1018-1024. https://doi.org/10.30491/jabr.2022.328558.1492

Bakeman, R. (1978). Untangling streams of behavior: Sequential analysis of observation data. In G.P. Sackett (Ed.), *Observing Behavior, Vol. 2: Data collection and analysis methods* (pp. 63-78). University of Park Press.

Bakeman, R., & Quera, V. (2011). *Sequential analysis and observational methods for the behavioral sciences*. Cambridge University Press. http://dx.doi.org/10.1017/CBO9781139017343

Berlanga, V., Rubio, M.J., & Vilà, R. (2013). Cómo aplicar árboles de decisión en SPSS [How to apply decision trees in SPSS]. *Revista d'Innovació i Recerca en Educació, 6*(1), 65-79. https://doi.org/10.1344/reire2013.6.1615

Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and psychological *measurement*, *20*(1), 37-46. https://doi.org/10.1177/001316446002000104

Erčulj, F., & Štrumbelj, E. (2015). Basketball shot types and shot success in diferent levels of competitive basketball. *PLOS ONE, 10*(6), 1-14. https://doi.org/10.1371/journal.pone.0128885

Escobar, M. (2007). *El análisis de segmentación: técnicas y aplicaciones de los árboles de clasificación.* Centro de Investigaciones Sociológicas.

Fernández, J., Camerino, O., Anguera, M.T., & Jonsson, G.K. (2009). Identifying and analyzing the construction and effectiveness of offensive plays in basketball by using systematic observation. *Behavior Research Methods, 41*(3), 719-730. https://doi.org/10.3758/BRM.41.3.719

Fernández, J.A., & Piñar, M.I. (2017). Estudio de las fases de ataque en baloncesto infantil masculino: diferencias entre ganadores y perdedores. *Cuadernos de Psicología del Deporte, 17*(3), 207-216. https://revistas.um.es/cpd/article/view/314031

Gabín, B., Camerino, O., Anguera, M.T., & Castañer, M. (2012). Lince: multiplatform sport analysis software. *Procedia - Social and Behavioral Sciences, 46*, 4692-4694. https://doi.org/10.1016/j.sbspro.2012.06.320

García-Rubio, J., Courel-Ibáñez, J., González-Espinosa, S., & Ibáñez S.J. (2019). La especialización en baloncesto. Análisis de perfiles de rendimiento en función del puesto específico en etapas de formación. *Revista de Psicología del Deporte, 28*(1), 132-139. https://archives.rpd-online.com/article/download/v28-n3-garcia-courel-gonzalez-etal/2771-14012-1-PB.pdf

Gómez, M.A., & Lorenzo, A. (2007). Análisis discriminante de las estadísticas de juego entre bases, aleros y pivots en baloncesto masculino. *Apunts Educación Física y Deportes*, 87, 86-92. https://www.redalyc.org/pdf/5516/551656956010.pdf

Kubatko, J., Oliver, D., Pelton, K., & Rosenbaum, D.T. (2007). A starting point for analyzing basketball statistics. *Journal of quantitative analysis in sports*, *3*(3), 1-22. https://doi.org/10.2202/1559-0410.1070

Landis, J.R., & Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*,159-174. https://doi.org/10.2307/2529310

Lapresa, D., Anguera, M.T., Alsasua, R., Arana, J., & Garzón, B. (2013). Comparative analysis of T-patterns using real time data and simulated data by assignment of conventional durations: the construction of efficacy in children´s basketball. *International Journal of Performance Analysis in Sport, 13*(2), 321-339. https://doi.org/10.1080/24748668.2013.11868651

Lee, C.S., Cheang, P.Y.S., & Moslehpour, M. (2022). Predictive analytics in business analytics: Decision tree. *Advances in Decision Sciences, 26*(1), 1-29. https://doi.org/10.47654/v26y2022i1p1-30

Lorenzo, A., Gómez, M.A., Ortega, E., Ibáñez, S.J., & Sampaio, J. (2010). Game related statistics which discriminate between winning and losing under- 16 male basketball games. *Journal of Sports Science and Medicine, 9*, 664-668. https://pmc.ncbi.nlm.nih.gov/articles/PMC3761811/

Magnusson, M.S. (2000). Discovering hidden time patterns in behavior: T-patterns and their detection. *Behavior Research Methods, Instruments, & Computers, 32*(1), 93-110. https://doi.org/10.3758/BF03200792

Mexas, K., Tsitskaris, G., Kyriakou, D., & Garefis, A. (2005). Comparison of effectiveness of organized offences between two different championships in high level basketball. *International Journal of Performance Analysis in Sport*, *5*(1), 72-82. https://doi.org/10.1080/24748668.2005.11868317

Milani, L., Grumi, S., Camisasca, E., Miragoli, S., Traficante, D., & Di Blasio, P. (2020). Familial risk and protective factors affecting CPS professionals' child removal decision: A decision tree analysis study. *Children and Youth Services Review*, *109*, 104687. https://doi.org/10.1016/j.childyouth.2019.104687

Monteiro, I., Tavares, F., & Santos, A. (2013). Comparative study of the tactical indicators that characterize the fast break in male and female under-16 basketball teams. *Revista de Psicología del Deporte, 22*(1), 239-244. https://archives.rpd-online.com/article/view/1329/931.html

Nunes, H., Iglesias, X., Del Giacco, L., & Anguera, M.T. (2022). The Pick-and-Roll in basketball from deep interviews of elite coaches: A mixed method approach from polar coordinate analysis. *Frontiers in Psychology, 13*, 801100. https://doi.org/10.3389/fpsyg.2022.801100

O'Donoghue, P. (2009). *Research methods for sports performance analysis*. Routledge.

Okazaki, V.H.A., & Rodacki, A.L.F. (2012). Increased distance of shooting on basketball jump shot. *Journal of Sports Science & Medicine*, *11*(2), 231-237. https://pmc.ncbi.nlm.nih.gov/articles/PMC3737873/

Ortega, E., Cárdenas, D., Sainz de Baranda, P., & Palao, J.M. (2006). Differences between winning and losing teams in youth basketball games (14-16) years old. *International Journal of Applied Sports Sciences, 18*(2), 1-11. https://www.semanticscholar.org/paper/Differences-Between-Winning-and-Losing-Teams-in-OrtegaToro-C%C3%A1rdenas/15fe02e2fe319c4c513e6838eac76efab4be9b8b

Ortega, E., Palao, J. M., Gómez, M.A., Lorenzo, A., & Cárdenas, D. (2007). Analysis of the efficacy of possessions in boys' 16-and-under basketball teams: differences between winning and losing teams. *Perceptual and Motor Skills*, *104*(3), 961-964. https://doi.org/10.2466/pms.104.3.961-964

Otzen, T., & Manterola, C. (2017). Técnicas de muestreo sobre una población a estudio [Sampling Techniques on a Population Study]. *International Journal of Morphology, 35*(1), 227-232. http://dx.doi.org/10.4067/S0717-95022017000100037

PatternVision Ltd & Noldus Information Technology bv (2004). *Theme, powerful tool for detection and analysis of hidden patterns in behaviour*. *Reference manual, version 5.0*. Noldus Information Technology.

Piñar, M.I., Estévez, F., Ortega, V., Conde, J., Alarcón, F., & Cárdenas, D. (2014). Características de las fases de ataque en categoría infantil masculina. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 14*(54), 265-278. http://cdeporte.rediris.es/revista/revista54/artanalisis454.pdf

Rolland, G., Vuillemot, R., Bos, W., & Rivière, N. (2020, March 6-7). *Characterization of space and time-dependence of 3-point shots in basketball* [Conference presentation]. MIT Sloan Sports Analytics Conference, Boston, Massachusetts, United States. https://hal.archives-ouvertes.fr/hal-02482706

Romarís, I.U., Refoyo, I., & Coterón, J. (2012). La finalización de las posesiones en baloncesto: estudio de la acción de finalización. *Cuadernos de Psicología del Deporte, 12*(supp), 45-49. https://www.redalyc.org/pdf/2270/227025430004.pdf

Sampaio, J., Drinkwater, E.J., & Leite, N.M. (2010). Effects of season period, team quality, and playing time on basketball players' game-related statistics. *European Journal of Sport Science*, *10*(2), 141-149. https://doi.org/10.1080/17461390903311935

Serna, J., Muñoz-Arroyave, V., March-Llanes, J., & Lavega-Burgués, P. (2022). Análisis decisional de la finalización en baloncesto. *Cultura, Ciencia y Deporte, 17*(53), 173-192. https://doi.org/10.12800/ccd.v17i53.1896

Shamrat, F.M., Ranjan, R., Hasib, K.M., Yadav, A., & Siddique, A.H. (2022). Performance evaluation among id3, c4. 5, and cart decision tree algorithm. In G. Ranganathan, R. Bestak, R. Palanisamy, A. Rocha (Eds.), *Pervasive Computing and Social Networking: Proceedings of ICPCSN 2021* (pp. 127-142). Springer Singapore. https://doi.org/10.1007/978-981-16-5640-8_11

Sharma, H., & Kumar, S. (2016). A survey on decision tree algorithms of classification in data mining. *International Journal of Science and Research*, *5*(4), 2094-2097. https://doi.org/10.21275/v5i4.nov162954

Song, Y.Y., & Ying, L.U. (2015). Decision tree methods: applications for classification and prediction. *Shanghai Archives of Psychiatry*, *27*(2), 130-135. http://dx.doi.org/10.11919/j.issn.1002-0829.215044

Yang, W., & Zhou, S. (2020). Using decision tree analysis to identify the determinants of residents' CO2 emissions from different types of trips: A case study of Guangzhou, China. *Journal of Cleaner Production*, *277*, 124071. https://doi.org/10.1016/j.jclepro.2020.124071