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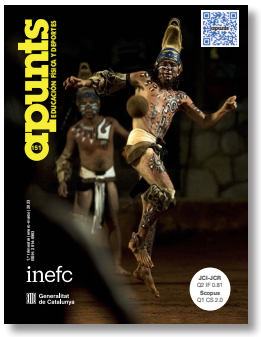

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Assessment of a Coding Tool to Analyse Goals in Football (CODITAG)

Rubén Sánchez-López[1]* , Ibon Echeazarra[1] & Julen Castellano[1]

[1] Physical Education and Sport, University of the Basque Country, Vitoria (Spain).

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***Corresponding author:**
Rubén Sánchez-López
rsanchez051@ikasle.ehu.eus

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A Mexican man in pre-Hispanic Aztec costume eludes the ball during a traditional "Juego de Pelota" (in Spanish), called by the Maya "pok-ta-pok" and by the Aztecs "tlachtli". Xcaret eco-park, Mexico
June 5, 2009
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Abstract

The most defining event in a football match is scoring a goal; therefore, the analysis of the dynamics of the game and the behaviours that lead to scoring goals can provide an important contribution to the identification of each team's most decisive attacking sequences in order to propose an appropriate strategy. Thus, the aim of this study was to set up and assess an *ad hoc* coding tool to analyse goals in semi-professional, amateur and training football. Based on several action-research processes, and using a set of experts through the Delphi method, a field-format coding tool was designed and assessed where each criterion is an exhaustive and mutually exclusive system of categories. The results demonstrated excellent content validity values, estimated through the degree of agreement (9.37 out of 10) and importance (9.66 out of 10). Similarly, excellent intra-observer reliability values were obtained ($k \geq .87$), and good to excellent inter-observer agreement values ($\bar{k} \geq .62$). The evaluation of generalisability using a three-facet design (observers, categories, goals) showed excellent reliability ($G > .90$), and perfect representativeness ($r^2 = 1$), showing that the variability is explained by the categories facet (in isolation or in interaction with the other facets). In conclusion, this study provides a valid and reliable tool that allows for the identification of the teams' most representative traits through the analysis of their goals.

Keywords: attacking phase, attacking sequence, football training, observational methodology, sporting performance, tactical analysis.

Introduction

The internal logic of play in socio-motor sports is influenced by the structure of scoring interactions, as they map out the ways in which scoring goals can take place, and define the way in which teams are able to change the score during game time, as well as the types of interaction that can take place between players and opposing teams (Parlebas, 2001). In the case of football, despite being able to interact with both teammates and opponents, the type of scoring interaction is antagonistic given that the scoreboard changes through scoring a goal, beating the opposition in the collective duel. Due to the nature of scoring interactions in football, only 1% of professional teams' possessions lead to scoring (González et al., 2020). Scoring a goal, therefore, is the most successful action in football and, so, analysing the scenarios that lead to goals can provide an important contribution to the identification of the most emblematic or critical game actions in order to understand the factors that provoke perturbations or imbalances in the attack/defence balance (Hughes, 1996). Therefore, observing the sequences of attacking play from previously defined criteria and categories allows us to understand how the teams behave when they score a goal, either in the moment of attacking transitions or in the execution of their attacks in the attacking phase.

In recent years, different observational tools have been used in order to analyse goals or sequences leading to goal-scoring opportunities. Some of these tools focus on recording exactly each event from the moment the team initiates the attacking sequence after regaining possession of the ball until the end of the action (Aranda et al., 2019; Barreira et al., 2013; Castellano, 2000; Echeazarra, 2014; Ortega-Toro et al., 2019; Papadopoulos et al., 2021; Sarmento et al., 2010; Tenga et al., 2010), while others do not look at the entire sequence of play (Caro Muñoz & Caro Muñoz, 2016; Kubayi, 2020; Ugalde-Ramírez & Rodríguez-Porras, 2021). Spatial characterisation is another criterion that is involved in many of these tools. Some record from where sequences of play start and which areas of the pitch the ball travels across until the end of its completion (Barreira et al., 2013; Castellano, 2000; Echeazarra, 2014; Ortega-Toro et al., 2019; Sarmento et al., 2010). Others have only focused on spatially characterising the last kick (Papadopoulos et al., 2021; Ugalde-Ramírez & Rodríguez-Porras, 2021), or the area where possession is initiated (Aranda et al., 2019; Caro Muñoz & Caro Muñoz, 2016; Kubayi, 2020; Papadopoulos et al., 2021; Tenga et al., 2010). Other criteria studied have been the result of the match before the goal or scoring opportunity (Barreira et al., 2013; Sarmento et al., 2010), the type of attack (Aranda et al., 2019; Kubayi, 2020; Papadopoulos et al., 2021; Sarmento et al., 2010; Tenga et al., 2010; Ugalde-Ramírez & Rodríguez-Porras, 2021), the behaviours that appear during the development and completion (Aranda et al., 2019; Barreira et al., 2013; Echeazarra, 2014; Ortega-Toro et al., 2019; Sarmento et al., 2010), the surface used in the last contact (Echeazarra, 2014; Ortega-Toro et al., 2019; Papadopoulos et al., 2021), the number of contacts made by the player (Echeazarra, 2014; Ortega-Toro et al., 2019), the number of passes before completion (Aranda et al., 2019; Caro Muñoz & Caro Muñoz, 2016; Kubayi, 2020; Papadopoulos et al., 2021; Sarmento et al., 2010), the typology or direction of the passes (Echeazarra, 2014; Sarmento et al., 2010; Tenga et al., 2010), the temporality of goals or goal-scoring opportunities (Barreira et al., 2013; Kubayi, 2020; Papadopoulos et al., 2021; Sarmento et al, 2010; Ugalde-Ramírez & Rodríguez-Porras, 2021), whether the home or away team finishes (Echeazarra, 2014; Sarmento et al., 2010), the centre of play (Barreira et al., 2013), the context of interaction between the two teams (Barreira et al., 2013; Castellano, 2000; Echeazarra, 2014; Ortega-Toro et al., 2019) and the context of opposition applied by the opposing team (Aranda et al., 2019; Ortega-Toro et al., 2019; Tenga et al., 2010).

Although some of these tools offer a high level of detail, they are often not sustainable in certain contexts, as they require high-quality recordings to record everything that it intends to. As a result, it would be of interest to design a tool that is sustainable in non-professional and training football and that, in addition to allowing delayed analysis, can be used live, and focuses in a particular way on what happens in the last seconds before the goal is scored; structured on the basis of some of the criteria considered and other criteria not yet considered in the scientific literature.

In light of the above, the aim of this study was to set up and assess a coding tool designed *ad hoc* to specifically analyse goals in football. The results of the present study will allow the tool to be applied both in the scientific field and in the field of sports competition analysis. In order to achieve this objective, the degree of validity and reliability of the data collected was determined to ensure the quality of the coding tool.

Methodology

Design

The study presented responded to a follow-up observational, nomothetic and multidimensional design (Anguera et al., 2011). It was follow-up because the data collection

was carried out in one season or competitive period over several matches; it was nomothetic because the data was recorded in a cross-sectional way (Hernández-Mendo & Molina, 2002), coding the goals of all the teams that participated in the same league, independently, without any link between them; and it was multi-dimensional because the goals were analysed according to several criteria. The data type was therefore concurrent and event-based, in other words, type II (Bakeman, 1978), because several dimensions were recorded in the same cluster, irrespective of the duration of the events. Therefore, data collection required the configuration of an *ad hoc* coding tool which, based on the structure of the observational design, was a combination of field format and category systems (Anguera & Blanco-Villaseñor, 2006).

Participants

To assess the tool, a total of 12 experts contributed their findings via Google Forms in two phases (n = 6, n = 6). Each of the selected experts met at least two of the following four requirements: (1) work as a coach or analyst with more than 10 years of experience; (2) be a coach with a minimum level 3 qualification; (3) have a degree in Physical Activity and Sport Sciences with a specialisation in football; (4) possess a Ph.D. on football.

For the design and optimisation of the coding tool, a sample of 477 goals corresponding to 18 match days of the 2019/20 season in the 3rd division of the RFEF group 7 (Madrid) was used. Subsequently, to calculate the reliability, a sample of 52 goals corresponding to match days 1 and 2 of the 2021/22 season in the 3rd RFEF Group 7 (Madrid) was used, with three observers for this process.

As no recordings were made directly on participants, no ethical consent was required as no invasive measures were taken to gather the data. The sequences of play were observed using the videos that the Madrid Football Federation offers openly and publicly on its website, in which all the goals are shown after each match day of 3rd RFEF group 7.

Coding Tool

The initial tool was developed using other previous tools aimed at the analysis of goals or attacking sequences as a reference (Barreira et al., 2013; Caro Muñoz & Caro Muñoz, 2016; Sarmento et al., 2010), and was used for the first time during the 2019/20 season. In that season, and alongside the recording of observed goals, the tool was modified to accommodate those criteria that could be analysed with their consequent exhaustive and mutually exclusive category systems. In the 2020/21 season, the tool was presented to the first group of experts (n = 6), who, using the Delphi method, provided their contributions in order to provide evidence of content validity. In the 2021/22 season, again following the Delphi method, a second group of experts (n = 6) assessed the tool, modifying it for analysing goals in football (CODITAG). The tool consists of a combination of a field format and exhaustive and mutually exclusive category systems, with 11 criteria, as shown in Table 1. It should be noted that 6 of these 11 criteria (match day, home team, away team, scoring team, minute of the goal, status of the scoreboard before the goal) do not depend on the analysis of the game action, as they can be verified without the need to observe the attacking sequence leading to the goal. Therefore, they have not been taken into account in the process of estimating validity and reliability. The criteria that had to undergo a process of estimating their validity and reliability for inclusion in the tool, due to their direct relationship with the observation of the game action, were: the type of attack, the contextualisation of the penultimate action, the contextualisation of the last action, the number of contacts of the last action and the surface used in the last contact.

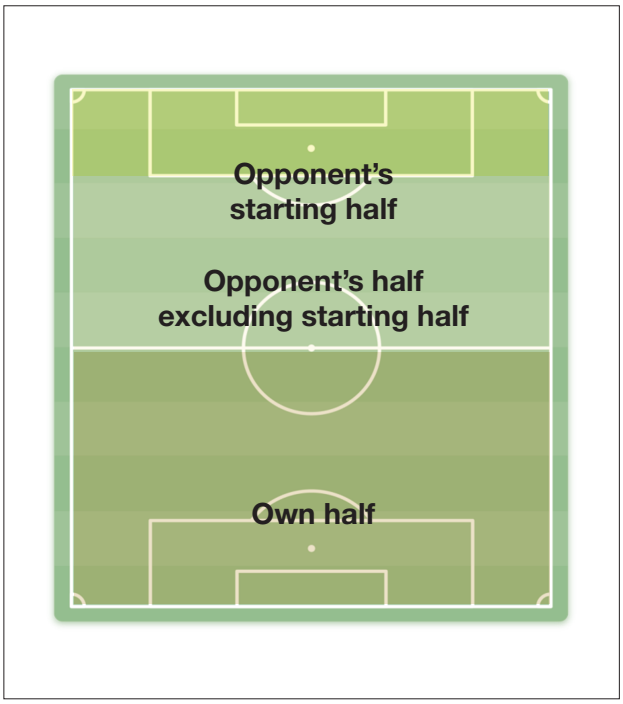


Figure 1
Recovery zones to record goals in transition.

Table 1
Criteria and categories of the coding tool for analysing goals in football -CODITAG-

Criterion	Categories	Definition for observation
Match day	1 to total number of days	No. of match days in which the match that gives rise to the analysed goal is played
Home team	1 to total number of teams	No. of the home team that gives rise to the analysed goal
Away team	1 to total number of teams	No. of the away team that gives rise to the analysed goal
Team that scores	Home	The home team scores the goal
	Away	The away team scores the goal
Minute	1 to the minute signifying the end of the match	Minute that the goal was scored
Scoreboard status before the goal was scored	Draw	Neither of the teams were winning before the goal
	Home victory	The home team were beating the away team by one goal
	2+ home victory	The home team were beating the away team by two or more goals
	Home defeat	The home team were losing against the away team by one goal
	2+ home defeat	The home team were losing against the away team by two or more goals
Type of attack	Positional combination play	The goal is preceded by a combination of passes by the team's players that allows them to progressively advance towards the opponent's goal, getting past an organised defence and completing most of the following indices: the opposing team is forced into their own half, great width of play, many players in front of the ball during the development of play, alternating pause and rhythm in the execution, very elaborate and positional attack.
	Quick combination play	The goal is preceded by a combination of passes by the team's players that allows them to advance quickly to the opponent's goal, getting past an organised defence and completing most of the following indices: distance and space is taken advantage of between the opponent's lines, verticality in the play, few players involved in the creation of play, great rhythm and speed in the execution and simplicity in a completion.
	Direct attack	The goal is preceded by a long throw-in to the team's attacking line over the opponent's midfielding area.
	Completion after recovery on exit of opposition's ball	The goal is preceded by a steal or interception of the ball in the opposition's starting end (see Figure 1).
	Counter-attack after recovery at the opposition's end	The goal is preceded by a quick move by the team's players that allows them to advance towards the opposition's goal, getting past an unorganised defence. The ball is recovered in the opposition's half, excluding the opposition's starting end (see Figure 1).

Table 1 (Continued)
Criteria and categories of the coding tool for analysing goals in football -CODITAG-

Criterion	Categories	Definition for observation
Type of attack	Counter-attack at team's own end	The goal is preceded by a quick move by the team's players that allows them to advance towards the opposition's goal, getting past an unorganised defence. The ball is recovered in own half, excluding the opposition's end (see image 1).
	Set piece: foul in the penalty box	The goal is preceded by a set-piece action from a direct or indirect free kick that is kicked into the opponent's penalty box.
	Set-piece: foul to restart play	The goal is preceded by a set-piece action from a direct or indirect free kick that is not kicked into the opponent's penalty box.
	Set-piece: corner to the penalty box is touched in by an attacker	The goal is preceded by a set-piece from a corner. The corner is played into the box and the first contact is made by an attacker.
	Set-piece: corner to the penalty box is touched in by a defender	The goal is preceded by a set-piece from a corner. The corner is played into the box and the first contact is made by a defender.
	Set-piece: corner outside the box	The goal is preceded by a set-piece from a corner. The corner is not hit into the penalty box, is taken short or sought by an attacker outside the penalty box.
	Set-piece: throw-in	The goal is preceded by a set-piece from a throw-in.
	Penalty	The goal came from a penalty either directly or from a second action.
	Other	It is not properly indicated what precedes the goal or it is not possible to include it in any of the other categories.
Contextualisation penultimate action	Pass into space (outside-outside and outside-inside)	The player who scores receives a pass at the back of the last line of defence. The passer is outside the box.
	Pass outside the box (outside-outside and inside-outside)	The player who scores receives a pass outside the box. The passer can be inside or outside the box (not including passes into space and long balls).
	Pass inside the box (inside-in)	The player who scores receives a pass inside the penalty box. The passer is also inside the box.
	Pass or cross from the wing (outside-inside)	The player who scores receives a pass or cross inside the box from a runner on the wing.
	Long ball (outside-outside and outside-inside)	The player who scores receives a long ball (not including balls at the back of the defence which are considered passes into space).
	Through-pass (outside-inside)	The player who scores receives a pass inside the penalty box.
	Header	The player who scores receives a pass inside the box from the inside runner (excludes passes into space and long balls).
	Rebound	The player who scores takes advantage of a rebound or a failure to clear the ball.
	Steal-interception	The player who scores steals the ball or intercepts a pass.

Table 1 (Continued)
Criteria and categories of the coding tool for analysing goals in football -CODITAG-

Criterion	Categories	Definition for observation
Contextualisation penultimate action	Throw-in	The player who scores receives the ball from a throw-in.
	None	Usually penalties and direct free kicks.
	Other	It is not properly indicated how the scoring player receives the ball or it is not possible to include it in any of the other categories.
Contextualisation last action	1v0 (empty goal)	The player who scores the goal shoots with no challenge from the opposition between the ball and the goal (not including scenarios where the goalkeeper or the last defender is dribbled past).
	1vP	The player who scores the goal shoots or dribbles to finish with only the goalkeeper or a defender marking them (not including completions).
	Completion	The player who scores the goal contacts the ball in the air (not including goals from outside the box or empty goals).
	Inside shot (no 1vP)	The player who scores the goal shoots inside the penalty box with at least one defender and the goalkeeper marking them. Contact with the ball is at ground level.
	Outside shot	The player who scores the goal shoots from outside the box (not including direct free kicks).
	Own goal	The player who scores the goal does so in their own goal.
	Direct foul	The player who scores the goal shoots a direct free kick.
	Penalty	The player who scores the goal kicks a penalty.
	Other	It is not properly indicated how the player scores the goal or it is not possible to include it in any of the other categories.
No. of contacts last action	1 touch	The player who scores the goal does so with their first touch of the ball.
	2 touches	The player who scores the goal does so after a previous control of the ball.
	3 touches	The player who scores the goal touches the ball three times.
	4+ touches	The player who scores the goal makes four or more touches with the ball.
Last contact surface	Right side	The player who scores the goal does so with their right foot.
	Left side	The player who scores the goal does so with their left foot.
	Header	The player who scores the goal does so with their head.
	Other	The player who scores the goal scores with any part of the body except their right foot, left foot or head.

Procedure

The design of the tool and the processes to provide evidence of validity and reliability were carried out in six stages (see Figure 2): (a) literature review and design of the provisional coding tool, (b) action research processes through piloting to ensure that the criteria category systems were exhaustive and mutually exclusive, (c) optimisation and content validation of the coding tool using two expert groups, (d) development of the inter- and intra-observer reliability estimation processes, (e) data quality control based on the analysis of generalisability and, finally, (f) quality assessment of the whole process using the checklist of methodological quality for studies based on observational methodology —MQCOM— (Chacón-Moscoso et al., 2019).

In the first stage, the selection of the observation categories that make up the tool was made through a literature review of a set of studies that had used coding tools for the analysis of goals in football (Caro Muñoz & Caro Muñoz, 2016; Sarmento et al., 2010; Tenga et al., 2010).

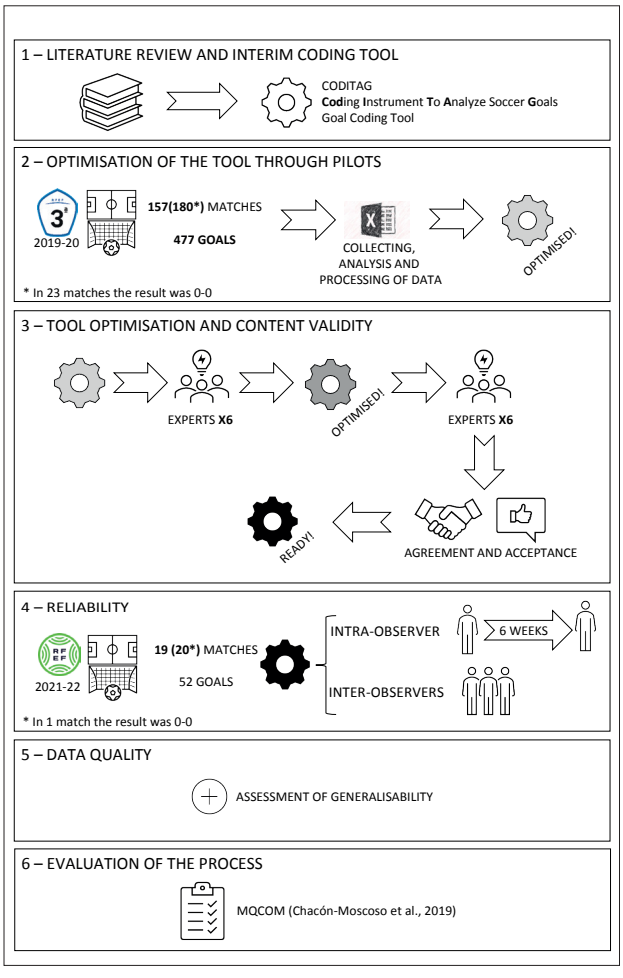
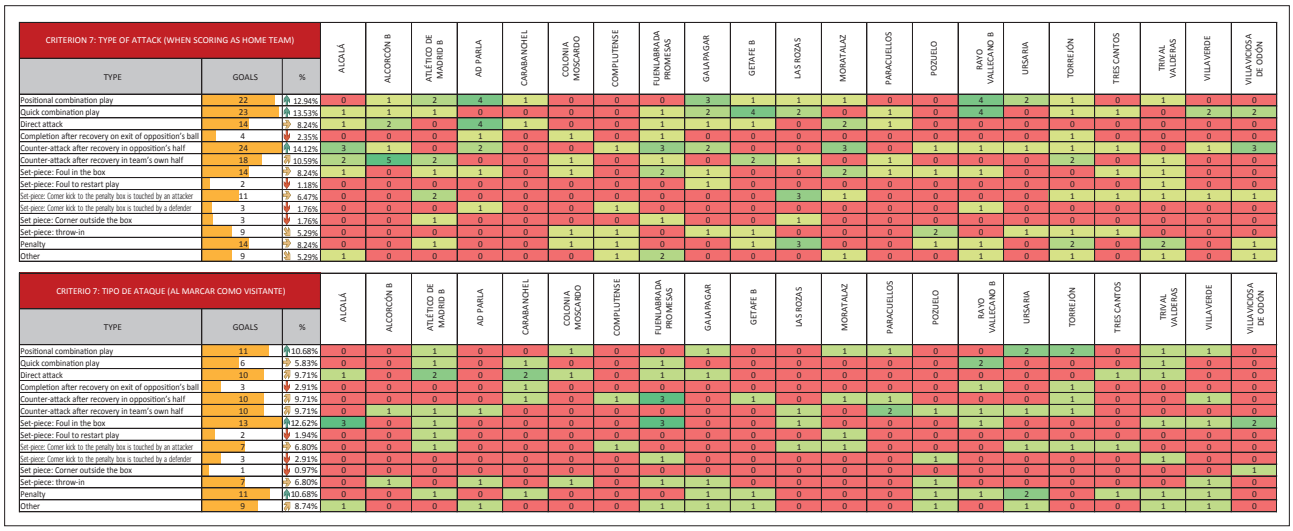


Figure 2
Phases to design and assess CODITAG.

In the second stage, the *ad hoc* coding tool was implemented for the data collection process using the software Microsoft Excel 365 (Microsoft Corporation, Washington, USA). The use of other types of more specific software within observational studies was discarded, because several criteria of the coding tool had a large number of categories (e.g. the criterion "minute of goal" has 90 categories). In this stage, the coding tool was used to record and analyse 477 goals in the 3rd national division group 7 (Community of Madrid), during 18 match days of the 2019/20 season. Alongside this process, the problems that arose in assessing the criteria that made up the tool were resolved to ensure that the category systems were exhaustive and mutually exclusive.

The third stage consisted of two phases: optimisation of the tool and content validity. In the first phase, through the suggestions of the first group of experts (n = 6), 5 new categories were created and the definitions of 11 categories were reformulated. In the second phase, the content validity of the tool was established by the second group of experts (n = 6) through the content validity coefficient (CVC) (Hernández Nieto, 2002). For this, a 1-10 scale was used with the experts to facilitate their responses on two factors: the degree of agreement and the degree of importance of each of the criteria and categories. Subsequently, the data was remodelled to a 0.1-1 scale, averaging the experts' responses for each criterion and category, according to factor. All of the tool's categories had agreement and acceptance values above 0.8, with all categories being accepted (Bulger & Housner, 2007). This was because the tool had undergone many pilots before being presented to this second group of experts. Finally, the resulting values were remodelled back to the 1-10 scale. After the coding tool was approved, it was updated in Excel.

In the fourth stage, the process of gathering evidence of the tool's reliability — both intra-observer and inter-observer — was carried out. Following the procedures developed in other works (Barreira et al., 2013; Fernandes et al., 2019; Ortega-Toro et al., 2019; Sánchez-López et al., 2021), 3 observers performed the analysis of the goals (n = 52) of the first and second league match day of the 3rd RFEF group 7 (Community of Madrid), 2021/22 season. Using the software SPSS Statistics for Windows, v19 (IBM Corporation, New York, USA), as well as the Microsoft Excel 365 add-in XrealStats, inter-observer reliability was calculated, and the criteria analysed as different between observers were discussed and analysed again, with the first author of the article acting as observer-moderator. Six weeks later, using the test-retest reliability method, one of the observers repeated the analysis process and the results obtained were compared with their previous analysis in order to calculate intra-observer reliability.



CRITERION 7: TYPE OF ATTACK (WHEN SCORING AS HOME TEAM)			ALCALÁ	ALCORCÓN B	ATLÉTICO DE MADRID B	AD PARLA	CARABANCHEL	COLONIA MOSCARDÓ	COMPLUTENSE	FUENLABRADA PROMESAS	GALAPAGAR	GETAFE B	LAS ROZAS	MORATALAZ	PARACUELLOS	POZUELO	RAYO VALLECANO B	URSARIA	TORREJÓN	TRES CANTOS	TRIVAL VALDERAS	VILLAVERDE	VILLAVICIOSA DE ODÓN
TYPE	GOALS	%																					
Positional combination play	22	12.94%	0	1	2	4	1	0	0	0	3	1	1	1	0	0	4	2	1	0	1	0	0
Quick combination play	23	13.53%	1	1	1	0	0	0	0	1	2	4	2	0	1	0	4	0	1	1	0	2	2
Direct attack	14	8.24%	1	2	0	4	1	0	0	1	1	1	0	2	1	0	0	0	0	0	0	0	0
Completion after recovery on exit of opposition's ball	4	2.35%	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Counter-attack after recovery in opposition's half	24	14.12%	3	1	0	2	0	0	1	3	2	0	0	3	0	1	1	1	1	1	0	1	3
Counter-attack after recovery in team's own half	18	10.59%	2	5	2	0	0	1	0	1	0	2	1	0	1	0	0	0	2	0	1	0	0
Set-piece: Foul in the box	14	8.24%	1	0	1	1	0	1	0	2	1	0	0	2	1	1	1	0	0	1	1	0	0
Set-piece: Foul to restart play	2	1.18%	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Set-piece: Corner kick to the penalty box is touched by an attacker	11	6.47%	0	0	2	0	0	0	0	0	0	0	3	1	0	0	0	0	1	1	1	1	1
Set-piece: Corner kick to the penalty box is touched by a defender	3	1.76%	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Set piece: Corner outside the box	3	1.76%	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Set-piece: throw-in	9	5.29%	0	0	0	0	0	1	1	0	1	1	0	0	0	2	0	1	1	1	0	0	0
Penalty	14	8.24%	0	0	1	0	0	1	1	0	0	1	3	0	0	1	1	0	2	0	2	0	1
Other	9	5.29%	1	0	0	0	0	0	1	2	0	0	0	1	0	0	1	0	1	0	1	0	1

CRITERIO 7: TIPO DE ATAQUE (AL MARCAR COMO VISITANTE)			ALCALÁ	ALCORCÓN B	ATLÉTICO DE MADRID B	AD PARLA	CARABANCHEL	COLONIA MOSCARDÓ	COMPLUTENSE	FUENLABRADA PROMESAS	GALAPAGAR	GETAFE B	LAS ROZAS	MORATALAZ	PARACUELLOS	POZUELO	RAYO VALLECANO B	URSARIA	TORREJÓN	TRES CANTOS	TRIVAL VALDERAS	VILLAVERDE	VILLAVICIOSA DE ODÓN
TYPE	GOALS	%																					
Positional combination play	11	10.68%	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	2	2	0	1	1	0
Quick combination play	6	5.83%	0	0	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0
Direct attack	10	9.71%	1	0	2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0
Completion after recovery on exit of opposition's ball	3	2.91%	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Counter-attack after recovery in opposition's half	10	9.71%	0	0	0	0	1	0	1	3	0	1	0	1	1	0	0	0	1	0	0	1	0
Counter-attack after recovery in team's own half	10	9.71%	0	1	1	1	0	0	0	0	0	0	1	0	2	1	1	1	1	0	0	0	0
Set-piece: Foul in the box	13	12.62%	3	0	1	0	0	0	0	3	0	0	1	0	0	0	1	0	0	0	1	1	2
Set-piece: Foul to restart play	2	1.94%	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Set-piece: Corner kick to the penalty box is touched by an attacker	7	6.80%	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	1	1	0	0	0
Set-piece: Corner kick to the penalty box is touched by a defender	3	2.91%	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0
Set piece: Corner outside the box	1	0.97%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Set-piece: throw-in	7	6.80%	0	1	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0
Penalty	11	10.68%	0	0	1	0	1	0	0	0	1	1	0	0	0	1	1	2	0	1	1	1	0
Other	9	8.74%	1	0	0	1	0	0	0	1	1	1	0	0	0	1	0	1	0	0	1	1	0

Figure 3
Descriptive analysis of goals according to the criterion "type of attack" using the criteria home, away and scoring team.

In the fifth stage, given the nature of the data analysed and in order to control their quality, the generalisability theory (Cronbach et al., 1972) was applied by modelling the different sources of variability or facets (observers [O], goals [G] and categories [C] of the taxonomic system), designing six possible models: [CG/O], [O/CG], [OG/C], [C/OG], [OC/G] and [G/OC].

In the sixth and final stage, the study was evaluated using the checklist of methodological quality for studies based on observational methodology —MQCOM— (Chacón-Moscoso et al., 2019), consisting of 20 items (1 point per item). The study scored 16.67 out of 18 points (2 items were not analysed).

Once the stages were completed, the coding tool could be used to code the goals, documenting the data in Excel. From this same application, the data is analysed descriptively through dashboards designed *ad hoc* to obtain the frequency and percentage of occurrence of each category within each criterion, as well as linking data between criteria in order to obtain more information. The following is an example (see figure 3) of the criterion "type of attack" on a sample of 273 goals corresponding to the first 12 match days of 3rd RFEF Group 7 (Community of Madrid) of the 2021/22 season.

Statistical Analysis

The coding tool was assessed in relation to the quality of the data. To achieve this, the content validity of the tool was reached qualitatively through the consensus agreement of a group of experts following the Delphi method and using the CVC (Hernández Nieto, 2002). The tool was also analysed quantitatively, calculating its intra-observer reliability using Cohen's kappa coefficient, and its inter-observer reliability using Fleiss' kappa coefficient for comparing more than 2 observers, as well as Cohen's kappa coefficient for comparing pairs of observers.

Results

Content Validity

To estimate the CVC (Hernández Nieto, 2002), the averages of the two factors used with the expert group were calculated following the Delphi method: the degree of agreement (9.37 out of 10), which reflects the clarity of the language ("do you think that the definition of the category is well elaborated and exclusive with respect to the other categories of the criterion?"), and the degree of importance or appropriateness (9.66 out of 10), which represents the theoretical and practical relevance ("do you think that the category should be part of the criterion?"). The scores obtained for both factors showed very high content validity.

Intra-Observer Reliability

In order to calculate the intra-observer stability index, the test-retest method was used by applying Cohen's kappa coefficient to data recorded by the same observer twelve weeks apart. The results showed agreement rates ($k \geq .87$) that could be rated as very good (Altman, 1991) for the five criteria analysed, for a coding tool of these characteristics.

Table 2
Intra-observer reliability through the test-retest method with Cohen's kappa coefficient.

Criterion	Cohen's kappa (*k*)
Type of attack	.91
Context penultimate action	.93
Context last action	.87
No. of scoring touches	.96
Last contact surface	.97

Inter-Observer Reliability

Inter-observer agreement was estimated from two perspectives. On the one hand, through Cohen's kappa coefficient (*k*) between pairs of observers, and, on the other hand, using Fleiss' kappa coefficient (*k*_) to calculate the total reliability for more than two observers ($n = 3$). The results obtained show good ($k > .60$ and $k_ > .60$) and excellent ($k > .80$ and $k_ > .80$) agreement values between observers from the two perspectives.

Generalisability Evaluation

The evaluation of generalisability was carried out using the *software* SAGT v1.0 build 218.0.1. (Hernández-Mendo et al., 2016). For this, three facets (observers [O], categories [C] and goals [G]) were used, resulting in six possible models (see table 4).

Based on the analysis, three aspects were addressed: reliability, variability and representativeness of the model.

Designs that used the "Categories" facet as a differentiating facet showed relative and absolute generalisability coefficients close to 1. It seems, then, that the observers agreed on their observations, linking this to a high reliability when discussing the generalisability of the results (close to 1).

The possible sources of variance showed that most of the variability (70.84%) is explained when the facet "Categories" is linked to the facet "Goals", the remaining part being explained by the facet "Categories" in isolation (15.38%) or in interaction with the other facets (13.78%). This reveals the heterogeneity shown by both the categories established and the goals observed, as well as the homogeneity in the observations, an ideal situation which means that the recording made by the observers has not influenced the values obtained, with no notable differences between the records (Usabiaga et al., 2013). Therefore, the categories can be considered as exclusive within the taxonomic system set up.

Lastly, the coefficient of determination (r^2) was estimated using the following formula ($r^2 = SCE/SCT$) as follows: with SCT being the total sum of squares, SCE the sum of squares explained, and SCR the residual sum of squares, STC = SCE + SCR (representing the ideal model STC = SCE, and SCR = 0). When using a three-facet design, there were seven possible sums of squares (each facet in isolation, the facets in pairs, and all three facets). Taking the four options where the facet "Categories" appears as a differentiating facet for the calculation of the SCE, it was obtained that SCR = 0, since the sum of squares of [O], [G] and [O][G] is 0.00, as shown in table 4. Therefore, $r^2 = 1.00$. This would mean that the model is fully representative.

Table 3
Inter-observer reliability calculated pairwise using Cohen's kappa and for more than 2 observers using Fleiss's kappa.

Criterion	Cohen's kappa (*k*)		Fleiss's kappa ($\bar{k}$)	
	Obs1/Obs2	Obs1/Obs3	Obs1/Obs2	*Obs1/Obs2/Obs3*
Type of attack	.79	.88	.86	.83
Context penultimate action	.77	.82	.86	.83
Context last action	.62	.78	.65	.71
No. of scoring touches	.92	.88	.89	.90
Last contact surface	.97	.97	1.00	.98

Table 4
Estimated values of the relative ($\xi\rho^2_{(\delta)}$) and absolute ($\xi\rho^2_{(\Delta)}$) generalisability coefficients for the designs: [CG/O], [O/CG], [OG/C], [C/OG], [OC/G] y [G/OC].

	Sum of squares type III	Degrees of freedom	Average squares	*Standard error*	%
Observers [O]	0.00	2	0.00	0.000	0.00
Categories [C]	116.982	42	2.750	0.004	15.38
[O][C]	3.128	84	0.037	0.000	0.42
Goals [G]	0.00	51	0.00	0.000	0.00
[O][G]	0.00	102	0.00	0.000	0.00
[C][G]	508.98	2142	0.238	0.002	70.84
[O][C][G]	60.205	4284	0.01	0.000	13.36
$r^2 = 1.00$					
Designs	[CG/O] $\xi\rho^2_{(\delta)} = .949$ and $\xi\rho^2_{(\Delta)} = .949$ [O/CG] $\xi\rho^2_{(\delta)} = .000$ and $\xi\rho^2_{(\Delta)} = .000$ [OG/C] $\xi\rho^2_{(\delta)} = .000$ and $\xi\rho^2_{(\Delta)} = .000$ [C/OG] $\xi\rho^2_{(\delta)} = .906$ and $\xi\rho^2_{(\Delta)} = .906$ [OC/G] $\xi\rho^2_{(\delta)} = .907$ and $\xi\rho^2_{(\Delta)} = .907$ [OC/G] $\xi\rho^2_{(\delta)} = .000$ and $\xi\rho^2_{(\Delta)} = .000$				

Discussion

The aim of this study was to outline the steps taken to set up and assess an *ad hoc* coding tool for analysing goals in football. The survey provides a valid and reliable tool that allows for the collection of data in a rigorous and relevant, yet agile and simple manner.

This tool was purposely built to allow its sustainable use in semi-professional, amateur and training football teams where sometimes coaching staff face serious complications when properly recording their matches and obtaining records of opposing teams. Therefore, it differs from other tools in existing scientific literature in that it is composed of criteria aimed at analysing the events that take place in the last few seconds before a goal, with the possibility of collecting live and delayed data. It is even possible to use it in match summaries that do not offer a full visualisation of the game sequences, as was done in the process of obtaining evidence of reliability in this study.

The coding tool consists of 11 criteria, five of which depend on the observation of the game action (the type of attack, the contextualisation of the penultimate action, the contextualisation of the last action, the number of contacts of the last action and the surface used in the last contact). Thanks to the process of obtaining evidence of validity, for the criterion "type of attack", a very broad classification of categories was developed to bring together all the expert contribution. Combination play was divided into positional and quick, in order to identify the strategic use of space (Amatria et al., 2019). In other words, in the positional combination play, width was prioritised over depth, while in the quick combination play, depth was prioritised over width. The counter-attacks were divided according to the recovery zone, and the set-piece was also distinguished according to the situation leading to the goal. For the criterion "contextualising the penultimate action" the large box was used as the main reference (inside-inside, inside-outside, outside-inside, outside-outside) to determine the type of pass, which greatly facilitated the classification of the play action. This idea was based on previous work (Echeazarra, 2014), in which the action of the player in possession of the ball is contextualised by taking the effective playing space as a reference (Castellano, 2000). When the penultimate action was not a pass as such, other categories were used (header, rebound, steal-interception, throw-in, no handball, other). For the criterion "contextualisation of the last action" the level of opposition (1v0, 1vP, rest) and again the large box (last contact inside or outside) were used as references. A distinction was also made as to whether the last action was with the ball in play or a set-piece (direct foul or penalty). Lastly, the criteria "number of contacts of the last action" and "surface area used in the last contact" were used, as seen in previous work as outlined in the introduction of this paper.

With regard to the contribution of the other six criteria, it can be noted that the criterion "match day" allows the tracking of goals by comparing their progression in a league championship. The criteria "home team" and "away team" allow the identification of patterns of attacking play in terms of scoring and conceding goals by teams when playing at home or away. This, undoubtedly, can be linked to the teams' game model, since knowing these game patterns allows us to identify and define their most characteristic features (Martín Barrero et al., 2021), in order to incorporate a specific tactical intention that fits with that game idea when designing training tasks (Lapresa et al., 2020). The criterion "scoring team" identifies whether it is the home or away team that scores the goal. The criterion "minute of the goal" allows the goals to be analysed by the time that they were scored. As mentioned previously, it has 90 categories, from minute 1 to minute 90, with the intention of establishing post-observation time intervals, due to the fact that in training football the duration of matches depends on the age category. The criterion "scoreboard status before the goal" allows us to analyse the goals in terms of the result, looking at whether the goals scored serve to widen the lead on the scoreboard or are decisive in drawing or winning the match (Fernández-Hermógenes et al., 2017).

In terms of the applicability of the tool, several options can be found in two different ways: research and competition. At the research level, one could differentiate how goals are scored or conceded using some of the criteria that make up the observational tool as independent variables, as well as to compare goals from different leagues or sport contexts. On a competitive level, one could analyse and compare the goals scored by a club's teams to establish differences and similarities between them, as well as compare the goals scored and conceded by one's own team with respect to teams in its league.

The coding tool is one that does not study the whole sequence of play. This is a limitation when it comes to going into detail on the action of the game, although it is true that it is an intentional fact that facilitates the recording of the goals in an easy way.

In terms of future prospects, the tool could include new criteria, with their respective category systems, which could support more in-depth analyses that would allow for other possible comparisons to be made.

Conclusions

As a conclusion of the study, it is worth mentioning that the presented coding tool presents optimal validity and reliability values. This ensures its use in possible research projects or specific scientific studies; as well as by clubs, sports performance analysis departments and coaches in order to analyse and assess how goals are scored, improving their teaching and training processes.

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