Article

Analysis of Corner Kick Success in Laliga Santander 2019/2020

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Abstract: It is well documented that set pieces represent 30% to 40% of goals scored in elite football, however most studies on set pieces have focused on the analysis of special competitions (World Cup, Euro etc). Thus, the purpose of this study was to examine the effectiveness of corner kick strategies used in LaLiga Santander during the 2019/2020 season, to identify the Key Performance Indicators (KPI) associated with the outcome of corners kicks and to develop a successful execution model. In total, 3,620 corner kicks executed in 380 matches were recorded by the observational methodology and examined through univariate (analysis of proportions), bivariate (Chi-square test for independence χ^2 and ROC area) and multivariate analysis (logistic regression). Results showed that 105 goals (2.9%) were scored from corner kicks. The following KPI were associated with outcome of corner kicks: final result ($\chi^2 = 10.644$, $p = 0.002$), time ($\chi^2 = 10.422$, $p < 0.005$), number of intervening attackers ($\chi^2 = 24.863$, $p < 0.001$), final attempt zone ($\chi^2 = 203.13$, $p < 0.001$), number of passes and second play ($\chi^2 = 26.071$, $p < 0.001$). The most effective execution model consisted of a direct delivery, shooting to goal from the front zone or second post. The results presented here enhance coaches´ understanding on factors that affect corner kicks performance and the most efficient mode of execution.

Keywords: Key performance indicators, set plays, observational methodology

1. Introduction

To win a football match a team must score more goals than the opposition team and these goals can come from open play or set pieces such as free kicks, corner kicks and penalty kicks. Set pieces represent 30% to 40% of goals scored in elite football (Armatas et al., 2007; Altarriba-Bartes et al., 2019), of which less than 2.5% corresponds to goals obtained through corner kicks (Ardá et al., 2014; Casal et al., 2015; Sainz de Baranda et al., 2011; Sánchez Flores et al., 2012; Silva, 2011). Despite the low incidence of goals from corner kick goals, 76% of these serve to define the outcome of the matches (Ardá et al., 2014; Casal et al., 2015), a circumstance that should incite increased interest from the

scientific community, increasing the number of studies on this topic, in order to obtain a greater knowledge about these games situations.

Consequently, more research is needed to shed more light on these types of game situations. In addition, previous studies have mainly focused on the analysis of special competitions, such as the FIFA World Cup (Acar et al., 2009; Ardá et al., 2014; Borrás & Sainz de Baranda, 2005; Carling et al., 2005; Casal et al., 2015; Maneiro et al., 2019; Mesonero & Sainz de Baranda, 2006; Sainz de Baranda & López-Riquelme, 2012; Sánchez Flores et al., 2012), the UEFA EURO (Casal et al., 2015; Ensum et al., 2000; Sánchez Flores et al., 2012; Yiannakos & Armatas, 2006) and the UEFA Champions League (Casal et al., 2015). We must take into consideration that previous studies (Bloomfield et al., 2005; Jones et al., 2004) confirmed that the behavior of players and teams can be influenced by the type of competition. The matches of these competitions may have unique and different characteristics to those of the domestic league competitions. They are competitions with few matches, the teams are made up of players from different clubs with different playing styles and with little time to build a common game model and most of these matches are direct elimination matches. These circumstances may incite tactical-strategic behaviors different from those of a regular competition and, therefore, the results obtained in these competitions may differ from those obtained in a domestic league.

Therefore, it is considered necessary to carry out analysis of set pieces in different domestic leagues, since the execution patterns of these situations can be shaped depending of the match location, as a consequence of the predominant styles of play, the quality of the teams and the football tradition of a specific country. If we also consider that this type of work is not too prolific (Pulling et al., 2013; Pulling & Newton, 2017; Siegle & Lames, 2012; Strafford et al., 2019; Taylor et al., 2005) and even less those that have focused on the Spanish First Division (Prieto-Lage et al.,

2021, Silva, 2011), considered one of the best leagues in the world, it is necessary to continue to analyze this game situation, to identify the factors that affect their performance and try to find more efficient execution models to obtain greater benefits in the execution of them.

In this sense, this work has been carried out, to try to deepen the study and characterization of the corner kicks of the Spanish First Division, setting ourselves three specific objectives. Identify and examine the effectiveness of the most frequent execution patterns of corner kick strategies used in LaLiga Santander, during the 2019/2020 season, identify the Key Performance Indicators (KPI) associated with the outcome of corners kicks and, subsequently, develop an execution model with more probabilities of success.

2. Materials and Methods

An observational methodology has been used and the design was N/S/M, nomothetic, inter and intrasessional follow-up, multidimensional and intensive (Anguera et al., 2018). The systematic observation carried out has been non-participant and active, using an observational sampling "*all occurrence*".

Sample

We analyzed 3,620 corner kicks corresponding to the 2019/2020 LaLiga Santander season (n 380). Footage of the corners taken in sampled games was transferred from the Wyscout software database (Wyscout, Wyscout Spar, Italy). According to the Belmont Report (Belmont, 1978) the use of public images for research purposes does not require informed consent or the approval of an ethical committee.

Observational tool

Four researchers, national football coaches and experienced in observational methodology designed an *ad hoc* observation tool (Table 1), consisting of a combination of field format and category system, which meets the requirements of exhaustiveness and mutual exclusivity, as proposed by

Anguera et al. (2018). For the selection of criteria, part of those defined in the work of Casal et al. (2015) were used.

Data reliability

All matches were registered and analyzed by two observers, who carried out the following training process: First, eight observing sessions were conducted on teaching the observers following the Losada and Manolov (2014) criteria and applying the criterion of consensual agreement (Anguera, 1990) among observers, so that recording was only done when agreement was produced. To ensure inter-reliability consistency of the data (Berk, 1979; Mitchell, 1979) the Kappa coefficient was calculated for each criterion, it revealed a strong agreement between observers, showing high reliability (0.92), according to Fleiss (1981) as a reference (Table 2).

Procedure and statistical analysis

The statistical analysis was carried out by the R program (v.3.4.1; Compare group library) and began with the transformation of the variable "Outcome" into three dichotomous variables. To do this, the category corner outcome attempt (ATTEMPT) was first created, by combining the categories of attempt on and off target, excluding goals. Subsequently, one category was classified as YES and the remaining two (goal and no attempt) as NO, in this way each dichotomous explained variable was constructed. This process was carried out in each of the three categories, to obtain the explained variables, "GOAL", "ATTEMPT", and "NATT" (No attempt to score from attacking team).

The Pearson's Chi-Square test (χ^2) was used to analyze the relationship between the categorical and explanatory predictor variables. For number of passes, the ROC area was used such that, if the area under the curve is at least 60% (95% CI), the relationship is considered significant (Bland & Altman, 1994). As a complement, a study was carried out of the proportions of the explained variables that had presented a significant relationship with the explained variables.

Next, a logistic regression was applied for each explained variable. With the intention of automatically selecting a reduced number of predictor variables and building the model with the best performance, a step-by-step logistic regression was performed, without compromising its precision. *Cross validation* was used to reduce bias and variability in estimating model performance. To do this, the sample was divided into two subsamples of similar size. The first sample ("*train.data*"), which was the one finally used, represented 60% and the second ("*test.data*") represented 40%.

Finally, to evaluate the model, an analysis of variance was carried out, for this, both the model as a whole and the predictors that comprise it were analyzed. It was considered useful if the prediction of the observations was improved with respect to the null model without predictors. The significance of the difference ("Deviance") of residuals between both models ("Null deviance" and "Residual deviance") was analyzed with a statistic that follows the chi-square distribution. All statistical significance was set at 0.05.

Table 1. Observation tool. Adapted from Casal et al. (2015)

	Criterion	Codes	Operational definition
1	**Final result**	**FR**	
Categories	Win	FW	The attacking team has scored more goals than opponent and won the match.
	Draw	FD	The attacking team has scored equal goals to opponent and draw the match.
	Loss	FL	The attacking team has scored fewer goals than opponent and lost the match.
2	**Time**	**TM**	
Categories	0-15 minutes		The corner kick was taken within 0-15 minutes of the match time.
	16-30 minutes		The corner kick was taken within 16-30 minutes of the match time.
	31 minutes - half time		The corner kick was taken within 31 minutes - half time.
	46-60 minutes		The corner kick was taken within 46-60 minutes of the match time.
	61-75 minutes		The corner kick was taken within 61-75 minutes of the match time.
	76 minutes - full time		The corner kick was taken within 76 minutes - full time.
3	**Match status**	**MS**	
Categories	Winning	WS	The attacking team has scored more goals than opponent at the time of the corner kick.
	Drawing	DR	The attacking team has scored equal goals to opponent at the time of the corner kick, or no goals were scored.
	Lossing	LS	The attacking team has scored fewer goals than opponent at the time of the corner kick.
4	**Laterality**	**LT**	
Categories	Natural	NA	The taker used right foot kick from right side or left foot kick from left side. The ball moved away from the goal.
	Switched	SW	The taker used right foot kick from left side or left foot kick from right side. The ball moved towards the goal.
	Neutral	NE	The ball is kicked with no curve with any foot and from either side.
5	**Delivery type**	**DT**	
Categories	Direct	DI	Corner kick that is delivered directly by the taker, with the intention of creating a goal scoring opportunity.
	Indirect	IN	The ball is sent to the shot zone after several touches (delivery into the box is made within a maximum of four passes, if corner exceeds this then it will be excluded as it becomes a possession in open play).
6	**Delivery height**	**DH**	
Categories	Ground	GR	The ball delivered to the shot zone along the ground when it rolls along the ground at all moments.
	Air	AR	The ball delivered to the shot zone through the air when it leaves the ground at some point during its path.
7	**Number of passes**	**NP**	
			Count the number of passes (excluding first pass from taker).
8	**Pass Zone**	**PZ**	Figure 1b
	1-7		Zone to which last pass is made for indirect corner kicks.
	No pass		Direct corner kicks.
9	**Defending post**	**DP**	
Categories	Near post	NP	A defending player stands at the near post.
	Far post	FP	A defending player stands at the far post.
	Both posts	BP	Two defending players stand both at near and far posts.
	None	NO	No defending player stands at the posts.
10	**Type of marking**	**MK**	
Categories	Zonal marking	ZN	All defending players in the effective play space (without considering the players of the post) were positioned at a particular spatial sector prior to the corner kick being taken. Defenders cover a particular space.
	Man-to-Man marking	MM	All defending players in the effective play space (without considering the players of the post) were positioned against a specific member of the opposition prior to the corner kick being taken. Defenders cover a particular player.

	Combined marking	CM	Some defending players were positioned at a particular spatial sector and some were positioned against a specific member of the opposition team. Combination of zonal and man-to-man marking.
11	**Interaction context**	**IC**	
Categories	Numerical equality	NEQ	The attacking team has the same number of players (without considering the players of the post) as the defending team in the effective play space (number of players of both teams in the space of sending the ball).
	Slight numerical inferiority	SNI	The attacking team has one or two players less (without considering the players of the post) than the defending team in the effective play space.
	Moderate numerical inferiority	MNI	The attacking team has three or more players less (without considering the players of the post) than the defending team in the effective play space.
12	**Number of intervening attackers**	**NA**	Without taker
Categories	0		No attacking player interacted with the ball.
	1-2		One or two attacking players interacted with the ball.
	3-4		Three of four attacking players interacted with the ball.
13	**Offensive organization**	**OF**	
Categories	Static	ST	The majority of attacking players who were in the effective play space, or the player who shot, stayed static.
	Dynamic	DY	The majority of attacking players who were in the effective play space, or the player who shot, performed distraction movements.
14	**Final attempt zone**	**FA**	Figure 1a
Categories	First post	FFP	The final attempt is made inside the "First post" zone.
	Centre	CN	The final attempt is made inside the "Centre" zone.
	Second post	SP	The final attempt is made inside the "Second post" zone.
	Near Side	NS	The final attempt is made inside the "Near side" zone.
	Front	FT	The final attempt is made inside the "Front" zone.
	Far Side	FS	The final attempt is made inside the "Far side" zone.
	Out of the box	OB	The final attempt is made outside the penalty area.
	Not attempt zone	NAZ	There is not attempt
15	**Corner outcome**	**OT**	
Categories	Goal	GO	The ball went over the goal line and into the net.
	Attempt on target	AT	The ball would have entered the net, but prevented by goalkeeper or defender.
	Attempt off target	AF	Attempt by the attacking team that was not directed within the dimensions of the goal. An attempt that made contact with the crossbar or either of the posts was classified as an attempt off target.
	No attempt	NA	No attempt to score from attacking team.
16	**Second play**	**SP**	Dynamic transitions
Categories	Possession by attacking team: 2nd play	PA	The offensive team started or continued the attack with a second play.
	Possession by defending team: goal	PDg	Defending team scored a goal with a dynamic offensive transition.
	Possession by defending team: attempt on/ off target	PDa	Defending team attempted to score a goal with a dynamic offensive transition.
	No second play	NSP	There is no dynamic transition.

Table 2. Inter-observer Agreement.

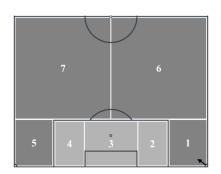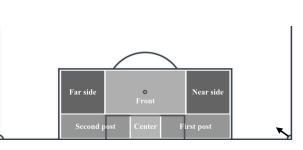| Criterion	k	Criterion	k
Final result	1.00	Defending post	0.78
Time	1.00	Type of marking	0.96
Match status	1.00	Interaction context	0.74
Laterality	0.95	Number of intervening attackers	0.96
Delivery type	1.00	Offensive organization	0.87
Delivery height	0.93	Final attempt zone	0.96
Number of passes	0.97	Corner outcome	0.97
Pass Zone	0.86	Second play	0.89
K_{Total}		**0.92**	

Figure 1. Final attempt zone

Figure 2. Pass zone

3. Results

Overview

From the 3,620 corner kicks that were analyzed, 24.8% finished with an attempt and 105 goals (2.9%) were scored. Regarding the execution pattern of corner kicks, the data reveal how they were executed more frequently in the final minutes of the matches (76-90+, 24.1%) and with drawing match status (51.1%). The offensive pattern most used by the teams was a direct delivery (78.6%), aerial (78.2%), to frontal zone (11.3%), dynamic organization (95.9%), with 1-2 intervening attacking players (53.2%), and slight numerical inferiority for attacking team (60.2%) (Table 3). In defense, most teams chose not to place players on the goal posts (96.1%) and to perform combined marking (98.6%).

The highest percentage of goals were obtained under the following conditions. The winning teams achieved a greater number of goals from corner kicks (50.5%), and most of the goals were obtained in periods 46-60 (25.7%) and 76-90+ (23.8%). The most effective delivery was natural (48.6%), direct (81%) and aerial (81.9%) to the frontal zone (29.5%), with the participation of 1 or 2 players (69.5%) and a dynamic organization (94.3%) (Table 3).

Bivariate & multivariate analysis – GOAL

Four categorical variables and Number of passes (ROC area, 60.77; 95%CI=0.5694-0.646) showed a significant relationship with GOAL (Table 4).

The main differences between the corners that ended in goals and those that did not were found in successful teams that scored more goals from corners than unsuccessful ones and that the corners executed in the period 46-60 and ended from the frontal zone of the area, presented a higher percentage of goals (Table 5).

The development of the logistic regression began with a model configured by the 5 significant predictor variables (AIC=784.26, residual deviation of 742.26, using the total sample). The final model was

configured by two predictor variables "Final result" and "Final attempt zone" (AIC=472.5, residual deviation=452.50). Cross-validation was applied using the sample "test.data", and the results support the selected model (AIC=333.3, residual deviation=313.3) (Table 6).

GOAL = constant + Final result + Final attempt zone

The estimation of the β coefficient of the variables provides us with the following information. For "Final result FW" (β=0.97), an increase in "Final result FW" was associated with an increase in the probability of achieving "GOAL" by an average of 2.14 units (odds). This means that the winning teams were more likely to score goals from corner kicks, or that obtaining goals through corner kicks provides greater chances of winning the match. For "Final attempt zone FFP" (β=-2.53) it indicates that increasing the attempts from First post would cause a decrease in the probability of achieving "GOAL" an average of 0.16 units (odds). For "Final attempt zone FT" (β=1.02) it implies that increasing attempt from Front zone would increase the probability of getting "GOAL" by 0.26 units (odds). For "Final attempt zone OB" (β=-2.11), indicates that an increase in attempt from Outside the box will be associated with a decrease in the probability of achieving "GOAL" by 0.08 units (odds) (Table 6). The analysis of variance shows how the model is significant (Table 7), with a proportion of correctly classified observations of 25.67%.

Bivariate & multivariate analysis – ATTEMPT

For this explained variable, three significant predictive categorical variables were obtained (Table 4) and the variable Number of passes (ROC area=61.32%; 95%CI=0.5967-0.6296). Table 5 shows how the main difference between obtaining and not obtaining attempt is found in the number of intervening attackers. The values of the logistic regression model detected three categories belonging to two explained variables (Table 8). Total sample (AIC=2920.1, residual deviation=2888.1), *train.data* (AIC=1816.7, residual deviance=1790.7), *test.data* (AIC=1112.1, residual deviance=1090.0).

ATTEMPT = constant + Num. of intervening attackers + Final attempt zone

The estimation of the β coefficients of the variables "Num of intervening attackers 1-2 (β=0.47) and "Final attempt zone SP" (β=1.00) is associated with the increase in the probability of achieving an attempt by an average of 1.60 and 2.73 units respectively. On the contrary, the estimation of the β coefficient of the variable "Final attempt zone NAZ" (β=-2.24), implies a negative relationship, logical since it means that there has been no auction. Table 7 shows how the model is significant with respect to the null model, with a proportion of correctly classified observations of 18.06%.

Table 3. Absolute frequencies and percentage occurrence for each criterion.

Category	Criterion	Codes	All Frequency	%	Goal Frequency	%
Final result	Win	FW	1.286	35.6	53	50.5
	Draw	FD	1.054	29.1	25	23.8
	Loss	FL	1.277	35.3	27	25.7
Time	0-15 minutes		530	14.7	11	10.5
	16-30 minutes		549	15.2	10	9.52
	31 minutes - half time		541	15.0	19	18.1
	46-60 minutes		593	16.4	27	25.7
	61-75 minutes		530	14.7	13	12.4
	76 minutes - full time		873	24.1	25	23.8
Match status	Winning	WS	688	19.0	28	26.7
	Drawing	DR	1.847	51.1	47	44.8

Laterality	Lossing	LS	1.082	29.9	30	28.6
	Natural	NA	1.570	43.4	51	48.6
	Switched	SW	1.613	44.6	43	41.0
	Neutral	NE	434	12.0	11	10.5
Delivery type	Direct	DI	2.844	78.6	85	81.0
	Indirect	IN	733	21.4	20	19.0
Delivery height	Ground	GR	787	21.8	19	18.0
	Air	AR	2.830	78.2	86	81.9
Number of passes	0		790	21.7	2	1.90
	1		2020	55.6	73	69.5
	2		396	10.9	12	11.4
	3		268	7.4	13	12.4
	4		98	2.7	4	3.80
	>4		44	1.1	1	0.95
Pass Zone	1		433	12.0	8	7.62
	2		54	1.49	2	1.90
	3		15	0.41	1	0.95
	4		5	0.14	0	0.00
	5		19	0.53	0	0.00
	6		213	5.89	8	7.62
	7		24	0.66	1	0.95
	No pass		2.854	78.9	85	81.0
Defending post	Near post	NP	94	2.60	3	2.86
	Far post	FP	48	1.33	1	0.85
	Both posts	BP	0	0.0	0	0.00
	None	NO	3.475	96.1	101	96.2
Type of marking	Zonal marking	ZN	47	1.30	0	0.00
	Man-to-man marking	MM	4	0.11	0	0.00
	Combined marking	CM	3.566	98.6	105	100
Interaction context	Numerical equality	NEQ	140	3.87	8	7.62
	Slight numerical inferiority	SNI	2.178	60.2	57	54.3
	Moderate numerical inferiority	MNI	1.299	35.9	40	38.1
Number of intervening attackers	0		1.345	37.2	15	14.3
	1-2		1.889	53.2	73	65.9
	3-4		383	10.6	17	16.2
Offensive organization	Static	ST	147	4.06	6	5.71
	Dynamic	DY	3.470	95.9	99	94.3
Final attempt zone	First post	FFP	160	4.42	10	9.52
	Centre	CN	105	2.9	22	21.0
	Second post	SP	97	2.68	8	7.62
	Near Side	NS	32	0.88	1	0.85
	Front	FT	409	11.3	31	29.5
	Far Side	FS	34	0.94	2	1.90
	Out of the box	OB	155	4.29	4	3.81
	Not attempt zone	NAZ	2.625	72.6	27	25.7
Corner outcome	Goal	GO	105	2.9	105	100
	Attempt	ATT	896	24.8	0	0.00
	No attempt	NA	2.616	72.3	0	0.00
Second play	Possession by attacking team: 2nd play	PA	563	15.6	10	9.52
	Possession by defending team: goal	PDg	8	0.23	0	0.00
	P. by defending team: attempt on/ off target	PDa	100	2.77	0	0.00
	No second play	NSP	2.946	81.4	95	90.5

Table 4. Analysis of the relationship between the different categories and outcome

	GOAL			ATT			NATT		
Category	χ^2	df	p-value	χ^2	df	p-value	χ^2	df	p-value
Final result	10.644	4	<0.05*	1.0429	2	0.59	0.9961	2	0.60
Time	10.422	10	<0.05*	10.422	6	0.10	9.2042	6	0.16
Match status	4.2295	6	0.12	0.1783	2	0.91	0.3221	2	0.85
Laterality	1.2183	3	0.74	5.1848	3	0.15	5.8962	3	0.11
Delivery type	0.2196	1	0.73	0.0357	1	0.85	2.891e-29	1	1
Delivery height	0.6451	1	0.42	0.0025	1	0.95	0.042966	1	0.83
Pass zone	4.0484	7	0.77	6.2893	7	0.50	5.6995	7	0.57
Defending post	0.1423	2	0.93	3.8036	2	0.14	3.4968	2	0.17
Type of marking	1.5466	2	0.46	0.0478	2	0.97	0.44882	2	0.79
Interaction context	4.7004	2	0.09	0.7080	2	0.70	1.8917	2	0.38
Number of intervening attackers	24.863	2	<0.001***	230.66	4	< 0.001***	271.35	4	< 0.001***
Offensive organization	0.3232	1	0.56	0.3232	1	0.56	0.0495	1	0.82
Final attempt zone	203.13	7	< 0.001***	918.69	7	< 0.001***	1097.2	7	< 0.001***
Second play	6.8580	7	0.44	26.071	7	<0.01**	33.47	7	<0.001***

Signif. codes: '***' 0.001 '**' 0.01 '*' 0.05
ATT = Attempt, NATT = Not attempt.

Table 5. Proportions analysis

	GOAL				ATT				NATT			
	NO		YES		NO		YES		NO		YES	
Category	Cat.	%	Cat.	%	Cat.	%	Cat.	%	Cat	%	Cat	%
Final result	FL	35%	FW	1%	∅	∅	∅	∅	∅	∅	∅	∅
Time	76-90	19%	46-60	0,1%	∅	∅	∅	∅	∅	∅	∅	∅
Num. of passes	1	52%	1	2%	1	19%	1	36%	∅	∅	∅	∅
Num. of inter. att.	1-2	49%	1-2	2%	0	34%	1-2	17%	1-2	19%	0	34%
Final att. zone	NAZ	72%	FT	1%	NAT	65%	NAT	8%	FT	1%	NAZ	64%
Second play	∅	∅	∅	∅	NSP	61%	NSP	21%	NSP	24%	NSP	59%

ATT = Attempt, NATT = Not attempt, Num. of passes = Number of passes, Num of inter. att. = Number of intervening attackers.

Table 6. Validated logistic regression model

Predictors	Estimate	S.Error	z value	Pr(>|z|)	2.5 %	97.5 %	Exp
(Intercept)	-1.80	0.52	-3.44	0.00***	-2.05	-0.81	0.24
Final result FL	0.06	0.48	0.14	0.88	-0.67	0.52	0.92
Final result FW	0.97	0.43	2.27	0.02*	0.24	1.31	2.14
Final attempt zone FFP	-2.53	1.09	-2.30	0.02*	-2.69	-0.94	0.16
Final attempt zone FS	15.29	8.69	-0.01	0.98	-3.41	-0.22	0.21
Final attempt zone FT	1.02	0.51	1.96	0.04*	-1.95	0.71	0.26
Final attempt zone NAZ	-2.91	0.50	-5.74	9.37	-4.13	-2.86	0.03
Final attempt zone NS	-1.05	1.14	-0.92	0.35	-5.34	-0.79	0.08
Final attempt zone OB	-2.11	0.84	-2.51	0.01*	-3.78	-1.51	0.08
Final attempt zone SP	-1.40	0.85	-1.64	0.10	-2.20	-0.42	0.27

Signif. codes: '***' 0.001 '**' 0.01 '*' 0.05
FL = Loss, FW = Wing, FFP = First post, FS = Far Side, FT = Front, NAZ = Not attempt zone, NS = Near Side, OB = Out of the box, SP = Second post.

Table 7. Variance analysis

GOAL	Df	Deviance Resid	Df	Df Resid Dev	Pr(>Chi)
NULL			1366	361.34	
Final result	2	5.526	1364	355.81	006309
Final attempt zone	7	54.401	1357	301.41	1.959e-09 ***
ATT	**Df**	**Deviance Resid**	**Df**	**Df Resid Dev**	**Pr(>Chi)**
NULL			1366	1515.6	
Num of intervening attackers	2	105.75	1364	1409.9	<2e-16 ***
Final attempt zone	7	226.43	1357	1183.4	<2e-16 ***
Number of passes	1	0.62	1356	1182.8	0.4312
NATT	**Df**	**Deviance Resid**	**Df**	**Df Resid Dev**	**Pr(>Chi)**
NULL			1366	1600.4	
Num of intervening attackers	2	122.817	1364	1477.6	< 2e-16 ***
Final attempt zone	7	285.551	1357	1192.0	< 2e-16 ***
Second play	3	6.588	1354	1185.4	0.08626.

Signif. codes: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
ATT = Attempt, NATT = Not attempt.

Table 8. Validated logistic regression model

Predictors	Estimate	S. Error	z value	Pr(>|z|)	2.5 %	97.5 %	Exp
(Intercept)	-0.32	0.35	-0.90	0.36	-1.03	0.38	0.72
N of interv att 1-2	0.47	0.22	2.05	0.03*	0.02	0.92	1.60
N of interv att 3-4	0.45	0.38	1.20	0.22	-0.29	1.20	1.58
F att zone FFP	0.69	0.43	1.60	0.10	-0.14	1.54	1.99
F att zone FS	1.18	0.84	1.39	0.16	-0.33	3.15	3.26
F att zone FT	0.19	0.35	0.54	0.58	-0.50	0.87	1.20
F att zone NAZ	-2.24	0.33	-6.79	1.11e-11***	-2.90	1.59	0.10
F att zone NS	0.63	0.58	1.09	0.27	-0.47	1.83	1.88
F att zone OB	0.45	0.40	1.10	0.26	-0.34	1.26	1.57
F att zone SP	1.00	0.50	1.97	0.04*	0.03	2.04	2.73
N passes	0.03	0.09	0.39	0.69	-0.15	0.23	1.03

Signif. codes: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
N of interv att = Number of intervening attackers, F att zone FFP = Final attempt zone First Post, F att zone FS = Final attempt zone Far Side, F att zone NAZ = Final attempt zone Not attempt zone, F att zone NS = Final attempt zone Near Side, F att zone OB = Final attempt zone Out of the box, F att zone SP = Final attempt zone Second Post, N passes = Number of passes.

Table 9. Validated logistic regression model

Predictors	Estimate	S. Error	z value	Pr(>|z|)	2.5 %	97.5 %	Exp
(Intercept)	-0.47	0.38	-1.22	0.2	-1.25	0.26	6.24e-01
N inter attackers 1-2	-0.52	0.19	-2.67	0.0**	-0.92	0.14	5.88e-01
N inter attackers 3-4	-0.36	0.26	-1.35	0.1	-0.88	0.16	6.95e-01
F attempt zone FFP	-0.03	0.45	-0.07	0.9	-0.91	0.86	9.67e-01
F attempt zone FS	0.92	0.72	1.28	0.1	-0.50	2.37	2.52e+00
F attempt zone FT	0.23	0.38	0.62	0.5	-0.49	1.02	1.27e+00
F attempt zone NAZ	2.74	0.36	7.52	5.11e-14***	2.05	3.49	1.55e+01
F attempt zone NS	-1.44	1.09	-1.31	0.1	-4.40	0.35	2.36e-01
F attempt zone OB	0.30	0.44	0.69	0.4	-0.54	1.18	1.35e+00
F attempt zone SP	-0.11	0.51	-0.21	0.8	-1.14	0.90	8.95e-01
Second play PA	0.06	0.23	0.28	0.7	-0.38	0.55	1.07e+00
Second play PDa	0.33	0.56	0.59	0.5	-0.65	1.61	1.39e+00

Signif. Codes: '***' 0.001 '**' 0.01 '*' 0.05
N of inter attackers = Number of intervening attackers, F attempt zone FFP = Final attempt zone First Post, F attempt zone FS = Final attempt zone Far Side, F attempt zone FT = Final attempt zone Front, F attempt zone NAZ = Final attempt zone Not attempt zone, F attempt zone NS = Final attempt zone Near Side, F attempt zone OB = Final attempt zone Out of the box, F attempt zone SP = Final attempt zone Second Post, N passes = Number of passes, PA = Possession by attacking team: 2nd play, PDa = Possession by defending team: attempt on/ off target.

4. Discussion

This study explored how LaLiga Santander teams executed corner kicks during the 2019/20 season, to determine their effectiveness, identify the variables associated with corner outcome, and describe an execution model with the highest probability of success.

The percentage of goals obtained from corner kicks in our work has been 2.9%, these data are similar to those reported in the works of Borrás & Sainz de Baranda (2005) that showed 2.47%, Taylor et al. (2005) 2.8%, Sainz de Baranda et al. (2011) 2.6%, Ardá et al. (2014) 2.3%, Casal et al. (2015) 2.2%, Carling et al. (2005) 3.2%, Pulling et al. (2018) 3.2% and Strafford et al. (2019) 3.1%. In all cases, a low incidence of goals obtained through corner kicks continues to be shown, taking into account their high frequency (average of 10 corner kicks per match, Casal et al., 2015). Therefore, this game situation needs to continue to be addressed by the scientific community and by technical bodies to improve its performance.

The most frequent execution model was, delivery type direct (78.6%), aerial (78.2%) and with the intervention of 1 or 2 attacking players (53.2%), being a classic and common pattern of execution of corner kicks used by teams of different domestic leagues and national teams, as shown by the studies that analyzed the English Premier League (Strafford et al., 2019) and the FIFA World Cup, UEFA EURO and UEFA Champions League (Casal et al., 2015).

As a defensive strategy, most teams have chosen not to place players on the goals posts (96.1), coinciding with the studies by Prieto-Lage et al. (2021) and Strafford et al. (2019). Our results show that the relative frequency of goals scored with players on the goal posts was 5.29%. However, the number of goals obtains without players on the goal post was 2.9%. Therefore, we consider that it is a wise decision, coinciding with the results obtained in the works of Casal et al. (2015) and Strafford et al. (2019), who indicate that the number of goals increases when placing more defenses on the goal posts.

As in the studies of Sainz de Baranda et al. (2011), Casal et al. (2015) and Strafford et al. (2019) the combined marking was the most used (98.6%). In addition, in the present work 100% of the goals were obtained under this type of marking, coinciding with the results of the works of Ardá et al. (2014) and Casal et al. (2015). However, we consider that these results are biased, since practically all corner kicks are defended with combined marking (98.6%).

The results of the bivariate analysis (Table 4) show how the performance indicators associated with the success of corner kicks (goal or attempt) were: final result, time, number of intervening attackers, final attempt zone, number of passes and second play. These results corroborated the findings of Ardá et al. (2014), Casal et al. (2015) and Pulling (2015) confirming that time, number of intervening attackers and final attempt zone show a strong relationship with the result of corner kicks and, therefore, can be considered KPI of these set pieces.

The winning teams showed greater effectiveness in this type of play, supporting the findings of previous studies (Ardá et al., 2014; Casal et al., 2016; Casal et al., 2015; Pulling, 2015; Strafford et al., 2019) indicating that they often have a decisive impact on the outcome of matches. Most of the goals were obtained in periods 46-60 (25.7%) and 76-90 (23.8%) confirming previous reports of Jinshan et al. (1993), Abt et al. (2002), Armatas et al. (2007), Saraiva (2007), Acar et al. (2009), Casal et al. (2015) and Prieto-Lage et al. (2021). These results could be explained by in the final stage, attackers are pushing for a goal and may commit more players for the draw or win. Also, straight after half time, teams may employ specific corner strategies based on analysis from the first half. Finally, the greater physical and mental fatigue of defenders can also make their actions less effective, as indicated by Casal et al. (2015). The intervention of between 1 and 2 attackers turned out to be the most effective form on the part of the teams. These data differ significantly from those obtained by Ardá et al. (2014), Casal et al.

(2015) and Prieto-Lage et al. (2021) who indicated that the most effective corner kicks were those in which 3-5 players participated in attack. These differences show the dynamic character of football that is constantly changing and evolving, teams constantly modifying their game models, to counteract or hinder the game of rivals, and also, as the styles and effectiveness of the behaviors of the teams may differ based on different types of competitions (FIFA World Cup, UEFA Euro, UEFA Champions League and different domestic leagues). The more effective attempt zone was the front and second post supporting the results of Pulling (2015) and Strafford et al., (2019). Although in our work the same subdivision is not used as in the aforementioned, the most effective areas correspond to each other. The most frequent and most effective number of passes was one pass, that is, the direct corner kick. These finding coinciding with the other previous studies (Casal et al., 2015, Pulling et al., 2017, Prieto-Lage et al., 2021). However, even though they showed higher success rate (38%), it is also found that 71% of these corners were not successful (Table 5). Finally, we can verify that not finishing the corner kick favors the appearance of second plays, both for the attacking team and for the defending (Table 10). On many occasions, a corner kick in favor becomes a counterattack for the defending team that ends with an attempt or goal. Therefore, to avoid this circumstance it is crucial for the attacking team to finish corner kicks.

Finally, the multivariate analysis results indicated that, goals from corner kicks increased the chances of winning the matches and that the probability of goal and attempt in corner kicks are increased if the final attempt zone is frontal or second post and if the number of intervening attackers is 1 or 2, that is, by means of a direct execution. Our execution model coincides with that of Ardá et al. (2014) and Casal et al. (2015), indicating that the final attempt zone with highest probability of success is the second post, on the other hand, it differs in that in these studies they indicate that the indirect is the execution model with highest probability of

success. We believe that this difference can be explained by the sample used, in the cited studies special competitions were analyzed and, in our work, Spanish LaLiga was analyzed and, as we indicated above, these types of competitions have particular characteristics. Another explanation may be due to changes in strategies, both offensive and defensive. The teams are continually modifying the execution model of the set pieces, to counteract the rival teams. Possibly, given the greater effectiveness of delivery type indirectly, teams have adopted new defensive strategies to prevent their rivals from carrying out this type of corner kicks.

The main limitation of the present study is that a specific domestic league is analyzed during one season. Therefore, the data cannot be generalized to other competition with different characteristics. Therefore, it would be necessary to carry out longitudinal studies that included more domestic leagues from other countries.

The main conclusions that can be drawn from this work can be summarized in: (1) Time, number of intervening attackers and final attempt zone can be considered KPI of corner kicks. (2) LaLiga Santander teams' execution model for corner kicks with the greatest probability of success consisted to deliver the ball directly and with the intervention of 1 or 2 attacking players to the second post or frontal zone, to be finished off from those zones.

5. Practical applications

The results of this work offer information to the coaches, about what are the KPIs in the corner kicks and the execution pattern whit highest probability of success. Coaches can use these findings to manipulate training tasks related to the management and success of these type of actions, thus increasing the potential for success. Considering the relative frequency of these set plays in elite soccer, improved corner kick performance is likely to increase scoring opportunities and make the game more attractive.

Conflicts of Interest: The authors declare no conflict of interest.

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