

Abstract

SOCCER VAR: Development of an observational instrument for the analysis of VAR related incidents in soccer

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Existing literature evidence reveals a significant gap in the use of Video Assistant Referees (VAR) in soccer, particularly regarding the availability of VAR observational methodology resources as a rigorous tool for analysing incidents. The aim of this study was to fill this gap by developing an observational instrument grounded in the laws of the game, the procedures for using VAR, the dynamics of the game, and the contexts that may influence referee decisions. The study underwent the following procedures: a literature review, construction of the instrument, discussions with experts, subsequent adjustments to the instrument, and observer training. To analyse the instrument criteria, an invitation was extended to six referee analysts (53.16 ± 5.19 years old) from the Brazilian Football Confederation (CBF), who are experts in the subject. All met the following criteria: a) be available to analyse the instrument criteria and procedures; b) have at least 15 years of experience in soccer professional refereeing; c) be an analyst,

referee, or refereeing instructor; and d) have completed the VAR course. The final VAR observational instrument comprised four criteria and their respective categories: game contexts (n=5), pre-incident (n=7), incident (n=6), and VAR (n=5), totalling 23 sub-criteria with 181 categories. Intra-observer reliability was demonstrated by a Cohen's Kappa value of 0.93, indicating high reliability of the instrument. (Please see Table 1).

Table 1. *Summary of the criteria of the instrument*

Criteria	Sub criteria	No. of Categories	Categories
Game Context	Phase	2	Tu1: first phase; Tu2: second phase
	Home Team Level	4	Ma1: High Level 1; Ma2: High Level 2; Mmed: Medium Level; Mbai: Low Level;
	Visiting Team Level	4	Va1: High Level 1; Va2: High Level 2; Vmed: Medium Level; Vbai: Low Level;
	Time Played	8	T1: 0min00sec to 14min59sec (1st half); T2: 15min00sec to 29min59sec (1st half); T3: 30min00sec to 44min59sec (1st half); Adi1: additional time (1st half); T4: 0min00sec to 14min59sec (2nd half); T5: 15min00sec to 29min59sec (2nd half); T6: 30min00sec to 44min59sec (2nd half); Adi2: additional time (2nd half).
	Game Score	5	P2: Losing by two goals or more; P1: Losing by one goal; G0: Tie; G1: Winning by one goal; G2: Winning by two goals or more.
Pre-Incident	Ball Possession	2	M: Home; V: Visitor
	Action 3: behaviors before the infringement	20	Tc3: Corner kick; L3: Throw-in; Tld3: Direct free kick; Tp3: Penalty kick; Tli3: Indirect free kick; Bc3: Dropped ball; Tm3: Goal kick; Ti3: Kick-off; Pc3: Short pass; Pl3: Long pass; Cond3: Ball control; Dri3: Dribble (1v1); Rec3: Reception; Du3: Duel/ dispute; Cruz3: Cross; Rem3: Shot/finishing; Gra3: Goalkeeper's offensive action (attack); Gad3: Goalkeeper's defensive action (defense); Adse3: Unsuccessful opponent's action; C3no: Not Observed.
	Location of Action 3: behaviors before the infringement	11	L3z1 to L3z10: Zones of the action of three behaviors before the infringement; L3no: Not Observed.
	Action 2: behaviors before the infringement	20	Tc2: Corner kick; L2: Throw-in; Tld2: Direct free kick; Tp2: Penalty kick; Tli2: Indirect free kick; Bc2: Dropped ball; Tm2: Goal kick; Ti2: Kick-off; Pc2: Short pass; Pl2: Long pass; Cond2: Ball control; Dri2: Dribble (1v1); Rec2: Reception; Du2: Duel/ dispute; Cruz2: Cross; Rem2: Shot/finishing; Gra2: Goalkeeper's offensive action (attack); Gad2: Goalkeeper's defensive action (defense); Adse2: Unsuccessful opponent's action; C2no: Not Observed.

	Location of Action 2: behaviors before the infringement	11	L2z1 to L2z10: Zones of the action of two behaviors before the infringement; L2no: Not Observed.
	Action 1: behavior before the infringement	20	Tc1: Corner kick; L1: Throw-in; Tld1: Direct free kick; Tp1: Penalty kick; Tli1: Indirect free kick; Bc1: Dropped ball; Tm1: Goal kick; Ti1: Kick-off; Pc1: Short pass; Pl1: Long pass; Cond1: Ball control; Dri1: Dribble (1v1); Rec1: Reception; Du1: Duel/ dispute; Cruz1: Cross; Rem1: Shot/finishing; Gra1: Goalkeeper's offensive action (attack); Gad1: Goalkeeper's defensive action (defense); Adse1: Unsuccessful opponent's action; C1no: Not Observed.
	Location of Action 1: behaviors before the infringement	11	L1z1 to L1z10: Zones of the action of one behavior before the infringement; L1no: Not Observed.
Incident	Type of Infringement	10	Tcogf: Tactic - Clear goal opportunity outside the area; Tcogd: Tactic - Clear goal opportunity inside the area; Tapf: Tactic - Promising attack outside the area; Tapd: Tactic - Promising attack inside the area; Ni: Nature - Reckless; Nt: Nature - Rough; Nufe: Nature - Use of excessive force; Atoff: Offside attack; Ato: Attack commits another infringement; Si: No infringement.
	Location of the Incident or Possible Incident	11	Liz1 to Liz10: Incident location; Lino: not observed.
	Location of the Referee	11	Laz1 to Laz10: Referee's location at the moment of the incident; Lano: not observed.
	Offending Team	3	Eqata: Attacking team; Eqdef: Defending team; Eqs: No infringement.
	First Technical Decision	7	Dt1sf: No foul; Dt1v: Advantage; Dt1td: Direct free kick; Dt1tp: Penalty kick; Dt1tli: Indirect free kick; Dt1bc: Dropped ball; Dt1ti: Kick-off.
	First Disciplinary Decision	3	Dd1sc: No card; Dd1ca: Yellow card; Dd1cv: Red card.
VAR	Type of Incident	4	VARGol: Possible irregularity before the Goal; VARPenal: Possible Penalty; VARCv: Possible red card; VARId: Identification error.
	Referee Reviews the Images	2	Aras: Reviewed the images; Aran: Did not review the images.
	Change in Decision	2	Mds: Changed the decision; Mdn: Maintained the decision.
	Second Technical Decision	7	Dt2sf: No foul; Dt2td: Direct free kick; Dt2tp: Indirect free kick; Dt2tli: Indirect free kick; Dt2bc: Dropped ball; Dt2ti: Kick-off; Dt2C: Continuation.
	Second Disciplinary Decision	3	Dd2sc: No card; Dd2ca: Yellow card; Dd2cv: Red card.

The instrument was tested in the analysis of 211 incidents involving VAR in the 2019 Brazilian championship. Of the match situations analysed, 100% involved a review, 146 of which were on-field and 65 factual. Initially enabling studies on the analysis of temporal patterns, the presence of many incomplete T-patterns showed a high variability of occurrences. The following sequential analysis showed statistically significant data calculated from the prospective and retrospective adjusted values ($Z > 1.96$; $p < 0.05$). This culminated in the investigation of polar coordinates, during which several significant associations ($Z > 1.96$; $p < 0.05$) involving the four focal behaviours were recorded: penalty, goal, red card, and misidentification. This study contributed to the development of the SOCCER VAR observational tool, which was considered suitable for scanning and analysing contexts and incidents with VAR interaction. This research offers a valuable approach by providing methodological rigour in the observation and analysis of VAR incidents, thereby contributing to filling the gap in the existing literature.

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