CHARACTERIZATION AND ANALYSES OF DRIBBLING ACTIONS IN SOCCER: A NOVEL DEFINITION AND EFFECTIVENESS OF DRIBBLES IN THE 2018 FIFA WORLD CUP RUSSIA™

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ABSTRACT

Purpose. Dribbling is a significant skill in soccer, owing to its effectiveness to create opportunities for scoring, and has been analysed from different perspectives, including the development of talented players. This study proposes a more comprehensive definition than the one earlier applied, considering key elements present in other suggestions found in the literature.
Methods. This study aims to validate the proposed definition, considering evaluations with experts working with events from the 2018 FIFA World Cup Russia™ and applying our definition in the analysis of the effectiveness of dribbling actions performed by elite players. We designed a protocol to collect the opinions from experts regarding the classification of events as dribble or non-dribble. To evaluate the quality of experts' opinions working with the novel dribbling definition, we computed the accuracy, precision, and Krippendorff's alpha coefficient to measure the agreement between them.
Results. The obtained results indicate that our definition of dribbling was clear and easily understood by the experts, which suggests that it could be useful to support soccer scouting of dribbling actions. The agreement value showed a near-perfect consensus between experts. We also analysed the effectiveness of dribbling actions considering the number of dribbles and success rates, from which we could observe that 2 CONMEBOL players performed more dribbles than the others.
Conclusions. The proposed 2-dimensional graphs for assessing the effectiveness of players and teams could be a useful tool for coaches to analyse technical actions toward detecting talented players.
Key words: soccer, dribbling actions, sports sciences, scouting

Introduction

Competitive success in soccer depends on the harmonious combination of technical skills, tactical behaviour, and physical abilities [1]. The dynamic context of the match requires a great technical ability of players in multiple skills [2], such as passing, ball control, interception, dribbling, and shooting [3, 4]. In this context, the importance of dribbling in clashes of one-to-one or more players is large for understanding the organization of ball possession of a team. Although pass is the most frequent action in soccer matches [4, 5], a dribble action can be fundamental to solve tactical match problems in some situations, mainly in offensive actions. A decisive dribble, for example, may lead to shots on target or to key passes aiming to increase the chances of scoring.

Dribbling analysis has already been addressed in several studies that aimed to measure the players' ability in different scenarios, and recent studies have exploited different alternatives to define dribbling actions. For instance, dribbling has been repeatedly defined in the literature as 'a player's action to pass an opponent while remaining in possession of the ball' [6] or 'an attempt to overtake another player with possession of the ball' [1, 7, 8]. Both definitions highlight the actions of trying to pass the opponent while keeping possession of the ball. Such definitions are not precise, as

they are not able to distinguish dribbling actions from other events that might seem similar to dribbling in real matches, such as ball protection and ball conduction.

Other studies try to put into perspective the confrontation with opponents. Some examples include: 'the player engaged in a 1 vs. 1 situation and with control of the ball tries to get around the opponent or push it away' [9]. However, in such definition, the direct confrontation between the player and the opponents has not been taken into consideration, although it constitutes a key element to distinguish dribbling from other actions in soccer. Furthermore, definitions such as 'a player's ability to dribble the ball' [10], which associate dribbling events with actions that aim to bypass the opponent, are unclear, since they are also true for strategies used in passing or conduction of the ball actions during real matches.

In summary, the currently employed definitions still suffer to decrease the inherent subjectivity in the analyses performed by evaluators or performance analysts [11]. By using such definitions, the dribbling actions are likely to be misclassified as other events, such as conduction of the ball or ball protection actions in which a player moves next to an opponent. Thus, we understand that a comprehensive definition of dribbling should consider the participation of opponents in the play, in such a way that the direct confrontation is noticeable when the player receives the ball and seeks to overtake the opponent.

Although some studies have been dedicated to the analysis of dribbling actions [12, 13], we can observe that there is still no definition concerning the differences between dribbling and performing other motor actions like direct confrontation between the player and his opponents, although these differences constitute a key element to distinguish dribbling from other actions in soccer, such as conduction of the ball or a ball protection action in which a player moves next to an opponent. This is paramount, however, not only to researchers but also to professionals and practitioners interested in improving the performance of athletes by comparing, measuring, and evaluating their effectiveness under the same criteria. Taking into account the key aforementioned elements, the main contributions of this work are: (i) a more comprehensive definition of dribbling as 'the ability of the player to possess the ball while performing motor actions in order to surpass or attempt to surpass the marking of one or more opponents in situations of direct confrontation'; and (ii) an overall analysis of the effectiveness of dribbling actions among elite players and teams.

With this in mind, we aimed to validate our definition of dribbling and measure the effectiveness of these actions in professional matches. Our study opens up several opportunities for applications, such as player evaluation and scouting or identification and development of talented young players since this ability could favour the selection of promising athletes in the sport [14].

Material and methods

This section presents the procedures and protocols designed for this study. Our methodology to validate the proposed definition and measure the effectiveness involved one gold level in soccer competitions, the 2018 FIFA World Cup Russia[TM].

The initial phase of this study comprised the collection of dribbling events through live transmission. We investigated all dribble events considering our definition, totalling 1251 events collected from 64 matches by using a routine coupled with the MATLAB® software. We watched a live broadcast television and extracted the temporal information and the success of the dribbling actions, in accordance with the following criteria: temporal information, which comprises the time (in seconds) and the period (e.g., first or second half of the match) of the event; the success or failures of the events. We defined success as the player's completing the action and maintaining ball possession, and failure as the dribbling player being tackled, committing a foul, or going out with the ball. We also downloaded all the 64 videos of matches of the 2018 FIFA World Cup Russia[TM] from the Footballia website.[1]

To validate the proposed definition, we designed experiments considering evaluations from 3 soccer experts holding master's or doctor's degrees in sports sciences, with at least 5 years of experience as a coach in youth and professional soccer programs, and being performance analysts. In total, 90 video clips were used during the evaluation in order to obtain the opinion of experts by applying a Python-based annotation tool. All video clips presented to the experts lasted 6 seconds. First, we randomly selected 45 out of 348 dribbling events identified only in knockout matches. Then, in order to obtain a robust and unbiased evaluation protocol, we scouted other 45 events that might seem similar to a dribbling action, such as ball protection and conduction of the ball, which we hereinafter referred to as non-dribble events.

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[1] http://www.footballia.net/competitions/world-cup (as of June 2020).

First, the annotation tool showed to the experts the definition of dribbling proposed in this study, and then presented 5 video clips of each class (dribble and non-dribble) to make the experts familiar with the adopted protocol. Second, the annotation tool presented to the experts the remaining 80 video clips, comprising 40 video clips of each class in a random order. The annotation tool collected the experts' opinions about the presence or absence of a dribbling event in the observed video clips. The tool also allowed the experts to watch a clip more than once if they had doubts about the event classification. To analyse the possible mistakes made during the experts' evaluations, we designed an evaluation protocol in accordance with which we collected their opinions in 2 rounds, with an interval of 4 weeks.

The agreement rate among the experts was evaluated by computing the Krippendorff's alpha coefficients [15] and the quality of experts' opinions by computing the accuracy and precision. The accuracy measured the fraction of video clips correctly classified by the expert, considering both classes: dribble and non-dribble. In turn, precision measured the fraction of dribble events correctly classified among all events classified as a dribble. To compute both measures, we first determined the ground truth labels of 80 video clips considering the majority vote of the experts' opinions. Then, we computed the confusion matrix for each expert considering the ground truth as true labels and the expert opinion as predicted labels. In this context, the expert opinion was classified as true positive (TP) when a dribble event was correctly rated as dribble and true negative (TN) when a non-dribble event was rated as non-dribble. Similarly, the incorrect answers were classified as false negative (FN) when a dribble was rated as non-dribble and false positive (FP) when a non-dribble was rated as dribble. Finally, we established the accuracy and precision rates for each expert using the equations as follows:

$$\text{accuracy (\%)} = [(TP + TN) / (TP + TN + FP + FN)] \times 100$$

$$\text{precision (\%)} = [TP / (TP + FP)] \times 100$$

We also analysed the effectiveness of dribbling actions considering the number of dribbles and the success rate variables for the national teams and players who completed at least 1 dribble. The number of dribbles was normalized by 90 minutes and the success rate was defined as successful dribbles number divided by the total number of dribbles. To highlight the performance of both teams and players during the competition, we used a 2-dimensional graph with the number of dribbles in X and the success rate in Y. The first quadrant (I) shows the X and Y greater than the respective medians, the second quadrant (II) shows the X lower than their median and Y greater than their median, the third quadrant (III) shows the X and Y lower than their medians, and the fourth quadrant (IV) shows the X greater than their median and Y lower than their median. Thus, the best performance should appear in the first quadrant (I) and the worst in the third quadrant (III).

Ethical approval

This research received the Ethics Committee approval of the School of Physical Education at the University of Campinas, Brazil, (CAAE 06754218.0.0000. 5404).

Results

Our evaluation aimed to measure the comprehensibility and clarity of the proposed definition of dribbling, which is important to make its use feasible in practice. For this, we measured the inter-rater agreement among the experts by using Krippendorff's alpha coefficients for the 2 experimental rounds, round #1 and round #2, and observed a high agreement rate of 0.87 and 0.93, respectively.

To analyse the assertiveness of experts in classifying dribble and non-dribble events in accordance with our definition, we measured the accuracy and precision rates for each expert, considering the majority vote among the experts' opinions as ground truth labels.

Figure 1 shows the results in terms of accuracy, implying the average values of 96.25 ± 4.51% and 97.08 ± 1.91% for the first and second experimental rounds, respectively. In terms of precision, we could observe the respective average values of 94.20 ± 7.98% and 94.57 ± 3.38%.

In Table 1, the actual class (second column) refers to our classification, and the next 6 columns stand for the experts' opinions in both experimental rounds. These results indicate that only 1 dribble event was classified as non-dribble, and 10 non-dribble events were classified as dribble by the experts. We also observed that 8 out of the 80 events (10.0%) were misclassified in the first round by at least 1 of the experts. In the second round, only 5 out of the 80 events (6.25%) were misclassified by at least 1 of the experts.

Figure 2 shows the effectiveness of dribbling actions performed by the national teams. The median values for the number of dribbles and the success rate were
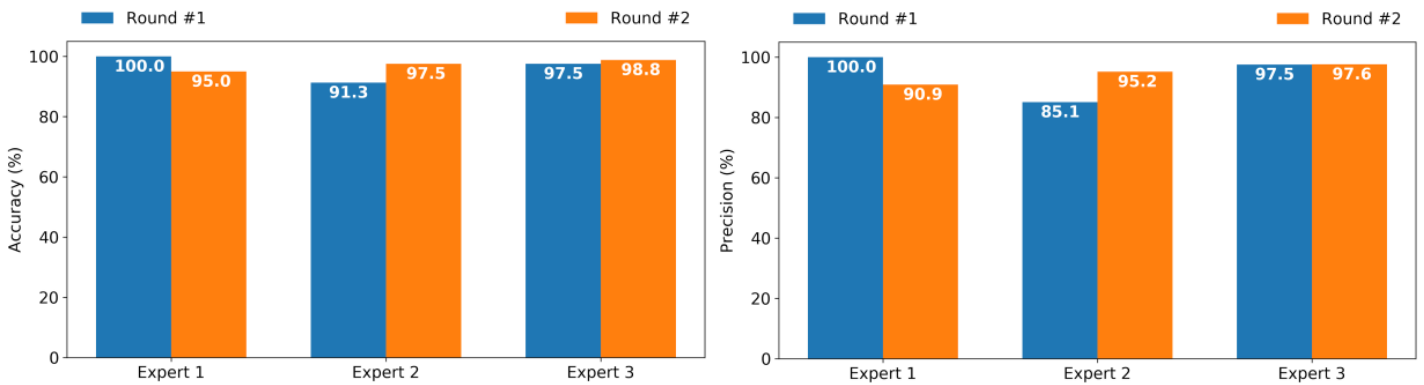
Figure 1. Performance results in terms of accuracy (left) and precision (right) for the 2 rounds of evaluation

Table 1. Experts' opinions as compared with our classification

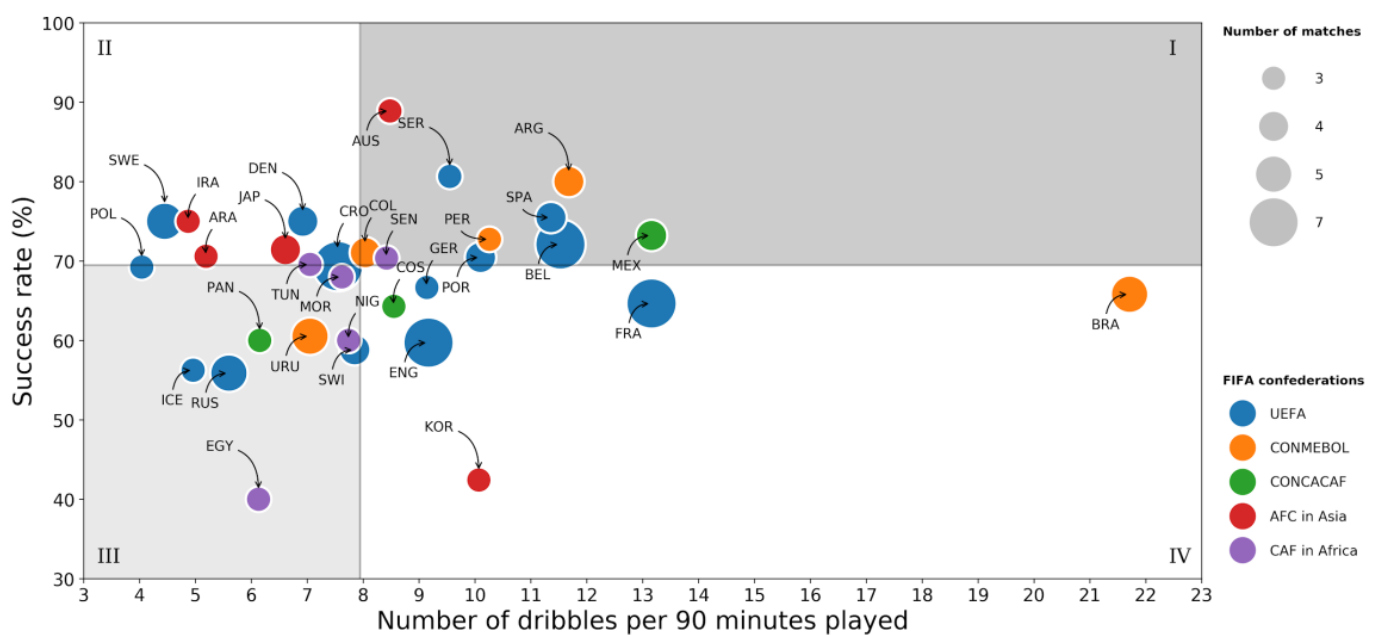| Event ID	Actual class	Expert 1		Expert 2		Expert 3	
		Round #1	Round #2	Round #1	Round #2	Round #1	Round #2
23	D	ND	D	D	D	D	D
46	ND	ND	ND	D	ND	ND	ND
58	ND	D	ND	D	ND	ND	ND
60	ND	ND	ND	D	ND	ND	ND
66	ND	ND	ND	ND	ND	ND	D
72	ND	ND	D	D	D	ND	D
76	ND	ND	ND	ND	ND	ND	D
81	ND	ND	ND	D	ND	ND	ND
84	ND	ND	ND	D	D	ND	ND
85	ND	ND	ND	D	ND	ND	ND
86	ND	ND	ND	ND	ND	ND	D

D – dribbles, ND – non-dribbles

Figure 2. Effectiveness of dribbling actions performed by the national teams, considering the number of dribbles and success rate
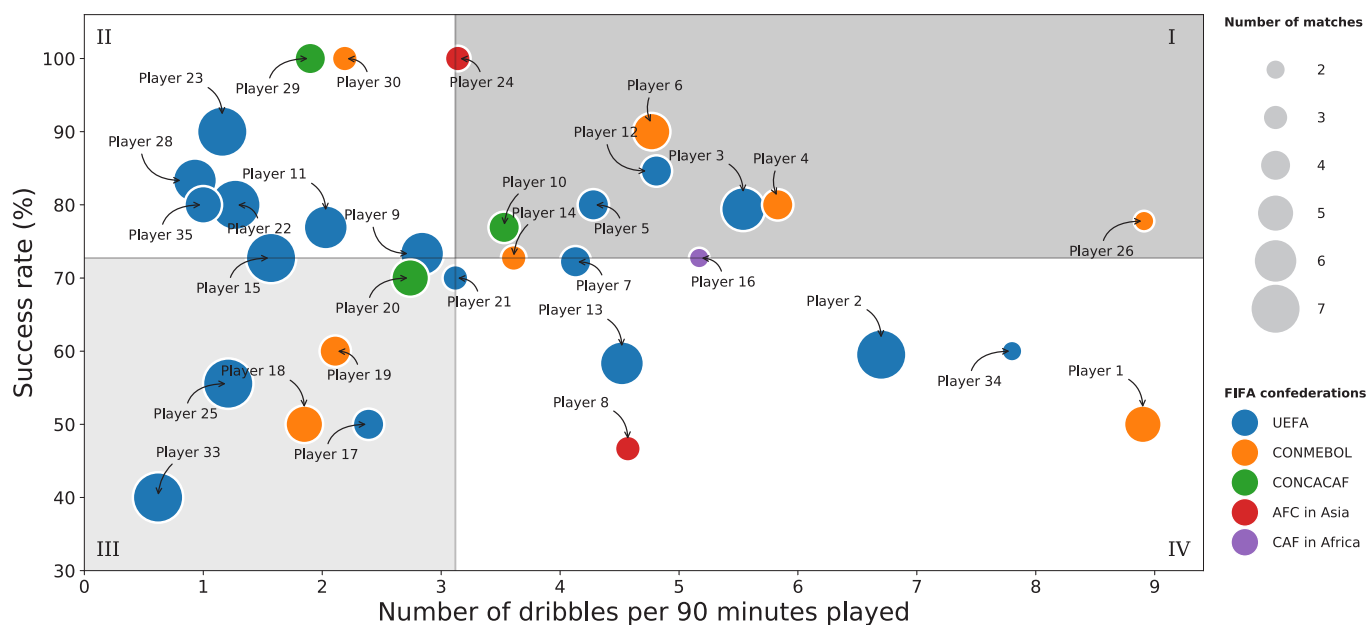
Figure 3. Effectiveness of dribbling actions performed by the players, considering the number of dribbles and success rate

8.04 and 69.57%, respectively. These results show that Brazil performed 21.71 dribbles, which was the highest number of dribbles. Furthermore, France and Mexico were the second and third teams that performed the highest number of dribbles, both with 13.16. In turn, Poland performed the smallest number of dribbles (4.04), followed by Sweden (4.45) and Iran (4.87). Regarding the success rate, Australia was the most successful team (88.89%), followed by Serbia (80.65%) and Argentina (80.00%). Egypt (40.00%), South Korea (42.42%), and Russia (55.88%) turned out the most unsuccessful teams.

We also analysed the effectiveness of dribbling actions performed by the players (Figure 3). Player 26 was the player who achieved the highest number of dribbles (8.91), followed by Player 1 (8.90) and Player 34 (7.80). In turn, Player 33 (0.62), Player 28 (0.93), and Player 35 (1.00) were the players with the lowest numbers of dribbles. Regarding the success rate, Player 24, Player 30, and Player 29 achieved the highest values (100.00%); Player 31 (20.00), Player 32 (20.00) and Player 27 (28.57) achieved the lowest values.

It is important to note that the 2-dimensional graphs of effectiveness reveal some characteristics that could be easier observed than if these variables were analysed individually. For instance, we revealed that player 26 and player 1 were both above the median of the number of dribbles (quadrants I and IV, respectively). However, these players presented differences in terms of success rate: The performance of Player 26 was above the median, while Player 1 presented a performance below the

median. Furthermore, in this graph, we can easily see the number of matches that each player participated in by looking at the size of the circles. The circle colours also contribute to a fast understanding of the effectiveness of teams from different FIFA confederations.

Discussion

The dribble is a technical-tactical strategy often used to destabilize the opponent's defensive organization and to create opportunities for scoring. Our aims were to validate our definition of dribbling and measure the effectiveness of such actions performed by elite players in high level soccer matches.

The metrics and protocols adopted in our evaluation aimed to measure the comprehensibility and clarity of the proposed definition of dribbling and to conduct a practical assessment of this skill. The high values of accuracy and precision obtained in both rounds (above 91.3% and 85.1%, respectively) suggest that our definition of dribbling was clear and easily understood by the experts. The accuracy values achieved reflect the ability of experts to classify both dribble and non-dribble events correctly, which means that both classes of actions were well-distinguishable by them. In turn, the precision values reflect the ability of the experts to classifying the dribble actions, without taking into consideration the errors in classifying the non-dribble events. In accordance with the kappa-like coefficient [16], the high values of inter-rater agreement obtained with Krippendorff's method showed a near-perfect

consensus between the experts in both round #1 and round #2, with agreement rates of 0.87 and 0.93, respectively. In light of these results, we can state that our definition was quite clear and easily understood by the experts, which is paramount to enable its use in practice.

To the best of our knowledge, there is 1 study that validated performance variables, including dribbling definition, by using a questionnaire designed to obtain the opinion of experts regarding the pertinence to match performance and correct definition of variable [8]. However, our methodology contemplates evaluations considering visual aspects of actions, which is more appropriate in this study owing to the complexity of this action. This allows us to validate our definition taking into account different match situations in the gold level in soccer competition.

Dribbling actions have already been studied in other works. Examples include the reports by Harper et al. [17], Konefał et al. [6], and Liu et al. [7]. Liu et al. [7] focused on the frequency of dribbling actions. Konefał et al. [6] analysed the frequency of dribbling with the goal of establishing relations with the status of the match. In turn, Harper et al. [17] investigated the dribbling occurrences in different periods of the match. None of those initiatives considered the definition of dribbling as we propose in this paper. Moreover, we assess the effectiveness of dribbling actions with the consideration of the success rate and number of dribbles.

Regarding the effectiveness of dribbling actions performed by the national teams, Brazil performed about 1.6 times more dribbles than the French team, the champion of the competition. Similar results were observed for Brazil by Açak and Düz [18] in their evaluation of dribbling occurrences for the quarter-final phase of the 2014 FIFA World Cup Brazil™. The number of dribbles observed in our study for Brazil, France, and Mexico is very impressive, being, for example, superior to the mean scores reported for the 48 matches of the 2014 FIFA World Cup Brazil™ [7].

The assessment of the success rate in dribbling events has also been investigated in the context of national leagues. The goal is to compare the performance of players in the most important leagues, where, usually, most of the high-skilled ones contribute. This kind of analysis could, for example, open opportunities for further investigation regarding the understanding of performance inconsistencies of athletes when playing for national teams and local clubs. New match strategies could therefore be defined on the basis of such analyses. Cerqueira et al. [19] evaluated the average number of dribbles in different important European

leagues, such as Bundesliga (Germany), English Premier League, La Liga (Spain), and Serie A (Italia), for 3 seasons (2011–2014). The observed scores were lower than the results of the Brazilian team in the 2018 FIFA World Cup Russia™ [19]. The closest score was reported for the German Bundesliga (13.7). However, these are different models of competitions; while the World Cup is a short competition with a knockout phase in the second stage, the European leagues operate within a system of promotion and relegation. Lago-Peñas and Lago-Ballesteros [20] analysed the average number of dribbling events in La Liga in the season of 2008–2009. According to them, the top-4 ranked teams were associated with a high number of dribbles, comparable with the results observed for Brazil in the 2018 FIFA World Cup Russia™.

The analysis carried out in our study for individual dribbling performance represented an important parameter for understanding the dynamics of offensive actions. The numbers of dribbles by Player 26 and Player 1 were much higher than those typically observed in the most important leagues, as shown by Trocchia et al. [21] in their analysis of 2 different seasons (2009–2010 and 2017–2018) of the Bundesliga, Premier League, La Liga, and Serie A.

Measurements that highlight the success rate of technical actions provide information about the players' technical skills proficiency [9]. The success in performing dribbling actions is important for maintaining the possession of the ball and thus for carrying out other subsequent technical actions. As could be observed, the use of a proper definition of dribbling opens opportunities to identify relevant parameters for performing both individual and collective analyses. Our study also proposed a 2-dimensional graph to assess the effectiveness of players and teams, which could be useful for coaches to analyse technical actions toward detecting talented players.

Additional investigations will be conducted to analyse the subsequent actions after a successful dribbling event, to build machine learning models to detect dribble events considering the proposed definition, and to use these results to detect and develop talents in soccer around the world. This study has the limitations of not considering other parameters, such as match status, difference between positions, tactics, and physical variables. Also, we applied a subjective analysis instead of an objective tool (video motion analysis, for example) unless FIFA could provide us with such kinematic data from FIFA World Cup™ matches. We expect to address these issues in future work. Future research efforts will focus on building machine learning models

to detect dribble events with the consideration of the proposed definition, as well as on constructing a larger dataset to support researchers in their studies related to the development of talented players.

Conclusions

Dribbling is a significant event in soccer owing to its potential to create opportunities for scoring. This study proposed a more comprehensive definition of dribbling, considering the key elements found in previous formulations. We also validated the proposed definition through evaluations by experts that presented a near-perfect inter-rater agreement (0.93). The obtained results indicate that our definition of dribbling is clear and easily understood by experts, which suggests that it could be useful to support investigations of soccer dribbling actions. Our definition also allowed to identify the distributions of the effectiveness of dribbling actions among national teams and players of the 2018 FIFA World Cup Russia™. Finally, we observed that 2 CONMEBOL players performed more dribbles than the other players. Our 2-dimensional graphs allowed us to assess the effectiveness of players and teams considering the success rate, number of dribbles, and number of matches played. This graphical tool could be useful for coaches to analyse technical actions toward detecting talented players. Future investigations will focus on automatically detecting dribbling actions to build a large database that would support researches in studying talent identification and development in soccer.

Disclosure statement
No author has any financial interest or received any financial benefit from this research.

Conflict of interest
The authors state no conflict of interest.

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