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TRILHA ESTUDANTIL

Goalkeeper: an application for goalkeepers evaluation

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***Abstract*—The statistic are commonly used in football to analyze a players performance. Their application is done through the scout, a method of data collection that is seen as the actions of the athletes regarding the technical and/or tactical aspects. After reviewing the literature, we realized even though there are several softwares for scouting applications, they do not perform a thorough evaluation of a goalkeeper actions. The goal of this work is to develop a scout system with support to the evaluation of goalkeepers, called Goalkeeper. The purpose of the system is to assist physical education professionals and goalkeeping instructors in conducting their instructor's training by analyzing statistical reports on a player's performance. The software was developed for the Android platform in order to allow the mobility of the user and use an application, since an evaluation can be performed through a videos, training camps or games. In order to evaluate the application, a questionnaire was applied to specialists. The results obtained were considered promising and allowed to observe the users' interest in the system.**

***Index Terms*—Soccer statistics, scout, goalkeeper, Android**

I. Introduction

SPORTS practice demands a great deal of exercise and specific training for their players to improve their techniques a to enhance the possibility of a correct response during games. Soccer is no exception. According to Sousa [17], sports training has the goal of increasing to the maximum the physical, technical and tactical abilities of the athletes. Besides the hard physical and practical workouts, which include the context of sports training and, specifically, soccer training, it is possible for the coach and his staff to take advantage of the data and occurrences within games. Using data is performed through statistical analysis.

According to Antonio et al. [1], several statistics in soccer are made through scouts. They evaluate technical and/or tactical aspects, depending on the goal defined for the data gathering and analysis. Based on the record of the actions performed by the players during the matches, it is possible to see patterns of play and strong and weak points for each player. Hence, the coach can define specific training methods for each athlete.

Recording several game situations and statistically analyzing the stored records are dull tasks. According to Silbermann [16], a soccer coach can identify only 30% of the actions performed during a match. In this context, some works in literature support using software that help the scouts' tasks. Nevertheless, most solutions are intended for outfield players, offering limited support for the analysis of the actions performed by goalkeepers.

The goalkeeper is the player with the greatest degree of freedom in the use of his body in soccer, given that he can use any body part to prevent goals. This liberty allows for a larger number of actions and movements, which must be mastered by the goalkeeper. This way, it is necessary to create an analysis for the specific actions of this player.

We would like also to highlight, as a negative aspect of the softwares found, the fact that they are limited to desktop platforms, what may cause great discomfort when used in a live game. The alternative would be compatibility with mobile devices.

According to Filho et al. [6], with the higher availability of mobile devices such as smartphones and tablets, with larger memory and processing power, these have become valuable tools for information access. According to Turban e Volonino [18], a technological trend around the world is the use of applications that communicate, connect and collaborate according to the users' needs. The ability to perform these tasks efficiently is achieved through the integration of communications, the internet, the high performance of the mobile devices and the digitalization of the media contents.

Hence, the goal of this work is to develop a mobile platform centered system that has the ability to evaluate goalkeepers, helping physical education and soccer professionals develop their training methods.

This paper is divided into seven sections. The second section presents related works and fundamental concepts. The proposed model is presented in the third section. In the fourth section we describe the system implementation. The results are described in the fifth section, through an evaluation of the system with potential users and, in the sith section, through a comparative analysis with other softwares. Finally, in the last section, we present our conclusions and our perspectives on future works.

II. Theoretical References

In this section we present the actions that goalkeepers should master, as well as the studies that approached the use of systems to support scouts and statistical analysis

within soccer. Certain works adapted statistical softwares and spreadsheets to perform analysis, other demonstrated the use of softwares specific for soccer scouting.

In spite of the existence of systems for statistical analysis within soccer, we are not aware of a system that supports mobile platforms and which allow us to evaluate all the actions within the goalkeeper responsibility.

A. The Goalkeeper

In modern soccer, a goalkeeper must master both defensive (which correspond to his main job) and offensive actions. According to da Cunha Voser et al. [4], the evolution of this sport made goalkeepers improve their passing with the foot and their reposition of the ball with their hands. In this context, the work of Gallo et al. [7], analyzed the motor skills practiced by goalkeepers during the games, in order to find a metabolic profile of the activities performed and create a training model that is in synchrony with the real demands and specificities of the function. Among those motor skills, the authors include action categories, encompassing both defensive and offensive actions. The defensive actions are "jump/fall/save" and "crossover defense". The offensive category corresponds to "repositions (passes and deep passes)". We also have an action in which the goalkeeper did not act or did not have the opportunity to do it: "no reaction".

The category "jump/fall/save" includes actions in which the goalkeeper makes the complete movement in order to defend the ball, independent of the fact whether or not he succeeded. The crossover defense refers to the action in which the player abandons the goal in order to intercept a ball that was launched over the area. Finally, the category repositions (passes and deep passes) is characterized by the action of bringing the ball back to the game, directing it to a fellow player, either with his hands or feets.

The categories were divided into actions:

- Jump/fall/save: low, medium and high central, right lateral and left lateral defense.
- Crossover defense: crossing, anticipation and facing down.
- Repositions: performed with the hands or the feet.
- No reaction: expectation position.

In Gallo et al. [7], we can find a simplified classification of plays as compared to a great number of actions and trainings described in da Cunha Voser et al. [4]. The latter details activities, warm up exercises and games situations for a goalkeeper. The actions include defensive and offensive goals and, usually, take into consideration the game context, such as, for instance, the field place where a strike towards the goal came from and the type of strike (kick or head shot).

This way, both Gallo et al. [7] and da Cunha Voser et al. [4] highlight the specificity of the actions performed by a goalkeeper during a match, and that most of those actions cannot be performed by a outfield player. Besides, we can see the importance of the analysis of the context of the play that caused the goalkeeper's action.

B. Related Work

Certain studies used softwares that help interpret data gathered during a match. For instance, in the work Castelão et al. [3], the goal was to identify different game patterns through the analysis of national teams that participated in the World Cup finals of 2006 and in the Euro Cups of 2004 and 2008. The authors evaluated 647 offensive game sequences, using the observational methodology to gather data (actions record) and feeding a digital spreadsheet. The data in the spreadsheet were then transcribed and processed by the SDIS (*Sequential Data Interchange Standard*) & GSEQ (*Generalized Sequential Querier*) softwares, in which the data analysis was performed.

According to Bakeman e Jordana [2], GSEQ is a software used to analyze sequential observational data. It calculates statistics about simple and contingency tables. On the other hand, SDIS is a language used to describe sequential data that comes from the direct observation of individuals. GSEQ is capable of compiling files formatted in SDIS (with the *.SDS* extension), generating *MDS* files (modified *SDS* files). *MDS* files, are analyzed with analytical procedures included within GSEQ.

Using spreadsheets was also demonstrated in the work of Gallo et al. [7]. The author decided to use a specific spreadsheet to record all the goalkeeper motor actions as the game went by. The spreadsheet analysis allows for the observation at all times of all goalkeeper interventions and the time between actions when he remained inactive. The spreadsheet used is illustrated in Figure 1, where the numbers in the first line correspond to the minutes, the number in the first column at the left correspond to the seconds (each space corresponds to five seconds). The description for each motor skill (E - Expectation position, CB - lower central save; EB - lower left corner save; CR - crossover; RM - hand reposition; RP - feet reposition) performed by the goalkeeper was duly noted in the space corresponding to the action.

	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'
05"								E								
10"															E	
15"												RP				E
20"								E	E						E	
25"															E	
30"																
35"					E			E	E							
40"					E/C B									E/E B		E/CR
45"					RM											
50"																E
55"						E/EB										
60"											E					

Source: Silbermann [16]

Fig. 1. Actions spreadsheet: each action is represented with a code considering the minutes (columns) and the seconds (lines) of the game time when it was performed.

Both techniques described above require a lot of work. In the first case, this is due to the fact that we need to

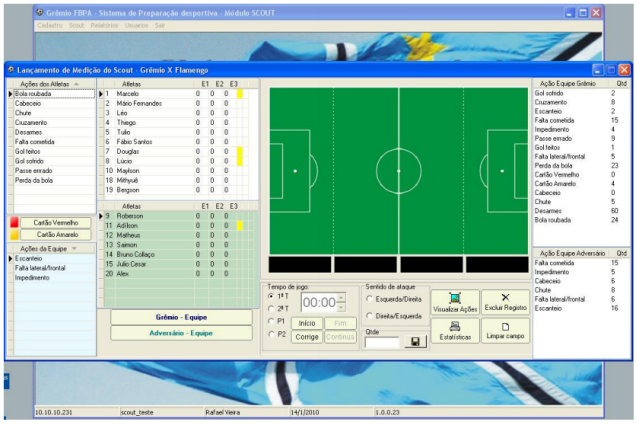
use more than one system. The complex task consisted in keeping a spreadsheet in a software and next, transcribe them into another software. In the second method, this is a statistical software, which is not specific for scout analysis (certain details, such as the play context cannot be analyzed with the software).

It can also be said that it is quite boring to fill the spreadsheet and then extract the information, as necessary in the second alternative. Also, since this is a manual process, it is quite prone to errors.

A more adequate way to perform scout evaluation is to use softwares that specialize in this kind of analysis. The work of Silbermann [16] shows that in Brazilian clubs, the technology is present both in matches and in trainings. The biggest clubs have a large department and resources dedicated to performance analysis, in which human computer interaction is fundamental to transform the soccer game into information of several types, such as graphs, tables and written reports.

The author also describes the efficiency acquired from using scout softwares based on the ethnographic method to analyze information, also looking for an increase in the efficacy within trainings and, consequently, within matches. The ethnographic method is characterized by the physical presence of the researcher while the player under study is observed.

One of the softwares mentioned by the author is the Grêmio FBPA (Grêmio *Foot-Ball* Porto Alegrense) system, shown in Figure 2. The system allows to record the possession time and to record the players actions (from both teams). The actions are divided into several categories that include wrong passes, steals, fouls and kicks. A database stores and recovers these information allowing trainers to identify the team deficiencies and helping them create the trainings.



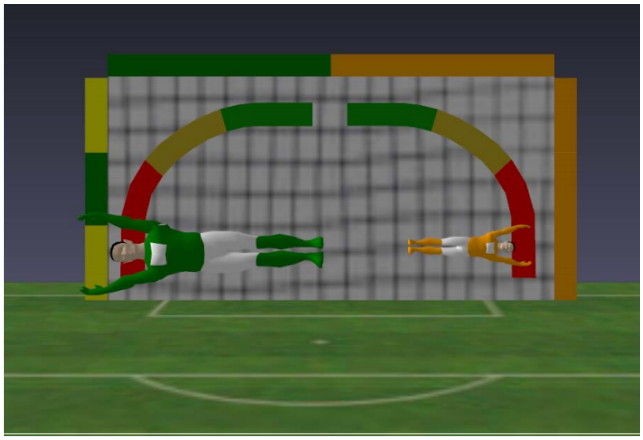
Source: Silbermann [16]

Fig. 2. Players performance analysis using the Grêmio FBPA system.

In spite of the fact that it is a valuable tool for soccer scouting, allowing to analyze the action of the outfield players and the evaluation of the plays context, the software does not support goalkeepers evaluation. Besides, given that it was developed for desktop systems, it can be quite hard to handle the system during a game, given the nature of the device in which it is used. A system for a mobile platform would be more adequate for this situation.

We found few scientific works in the literature which described scout softwares that evaluate goalkeepers. In this group, the work of Rusu et al. [14] show the addition of *Goalie Viewer* to the *Soccer Scoop* application, a scout software that focuses on outfield players. Adding this new software allowed for the evaluation of the actions performed by goalkeepers. The tool represents the individual dynamic of a goalkeeper as a virtual goalkeeper (Figure 3) whose body the software colours according the real goalkeeper performance during the game in order to identify the number of actions performed in a satisfactory and deficitary way. The same is done with a virtual replica of the goal.

In the example depicted in Figure 3, taken from Rusu et al. [14], we can see an analysis of the goalkeeper performance using *Goalie Viewer*. We can see that the goalkeeper had a deficiency with deflected balls. The goalkeeper angle showed that he deflected less than five balls outside the goal area are in both the considered games (left and right in red). The precision of the actions can be observed comparing the differences in size of the players models. The bigger the player, the more precise the action.



Fonte: Rusu et al. [14]

Fig. 3. Visualization shown by the *Goalie Viewer* system, in which the colours and player sizes indicate the goalkeeper's performance.

The visualization offer by *Goalie Viewer* is easy to understand and appreciate, which is its best characteristics. In spite of that, it is not possible to make a thorough analysis of the goalkeeper skills, because we lack numerical information, as well as the information of the plays' context. Besides, the software does not offer support for mobile platforms.

III. The proposed model

In this section, we present the proposed model for the development of a goalkeeper evaluation system, which we call *Goalkeeper*.

According to the concepts described in the subsection II-A, we modeled the set of actions on which the goalkeepers must be evaluated during matches, training or videos. Each set contains specific characteristics and is contained within the context of a play, which refers to the information that describes a scenario in which the goalkeeper's action was performed and includes data such as time elapsed in the game and the field sections which where the ball passed.

In order to illustrate this model, we created a class diagram (Figure 4), in which we show the classes that are responsible for evaluating the goalkeeper's actions.

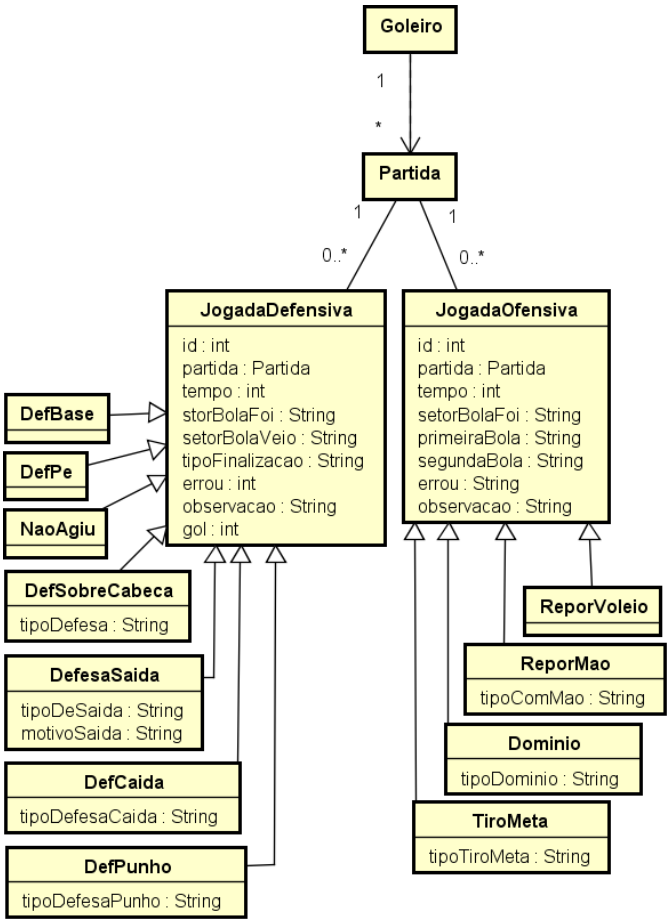


Fig. 4. Class Diagram for the *Goalkeeper* application.

In Figure 4 we can see that the goalkeeper can be evaluated in matches in which there can be plays than culminate in a goalkeeper's action. These actions were generalized into two types of plays:

- Defensive plays: the goalkeeper needs to save the goals. Usually, this happens when the adversary kicks towards the goal or towards a teammate near the goal, as well as in stopped ball plays, such as fouls and corners. In those plays, the context includes game time, field sector where the ball came from, field or goal sector where the ball went to, occurrence of error in the action, extra observation (optional), type of attack (if it happened) and occurrence of a goal in the play. Besides those context data, defensive plays can be characterized by the following actions: base defense, did not act, defense out of the post, defense with the head, defense falling down, defense with the foot and defense with the fist. The actions can include specific characteristics, such as in the case of a defense out of the post, in which it is necessary to inform what motivated the action (a crossover, a kick with the ball in play, a corner or a foul) and what type of technique was used to intercept the ball (kick, firm defense, punch, rebound, headshot or a body encounter motion).
- Offensive plays: in this situation, the goalkeeper does not need to save the ball, but pass it to a teammate or keep it under control. The context record includes game time, field sector where the goalkeeper received the ball, field sector where the ball went to, which player (either teammate or adversary) received the ball passed by the goalkeeper at first and at a second moment in the dispute, occurrence of error in the action and extra observation (optional). Besides the context data, offensive plays can be characterized by the following actions: ball control, game restart shot, hand toss and kick toss. The actions can also have specific characteristics, such as in the case of a control, in which it is necessary to inform the kind of control performed (high - above the waist, or low, below the waist).

It is important to point out that in Figure 4, the attributes of the classes *Goleiro* (Goalkeeper) and *Partida* (Match) were hidden to improve the scheme understanding. The same is applied to the methods of all the classes in that diagram.

The information recorded during evaluation are available to the coach in reports. These reports intend to portrait the decisions made by the goalkeeper, the game situations experienced, the quality of the actions performed and the field sectors from which the adversaries most attacked the goal. These information allow the coach to define game and training strategies.

In order to illustrate how to use the system, we developed some use cases (Figure 5). The use cases diagram, according to Kurtz et al. [9], shows the relationship between system functionalities and the involved actors. In the proposed system, there is a single actor, the coach.

The coach can keep a database of goalkeepers, can start an evaluation and also, look at the performance reports for each goalkeeper.

When starting an evaluation, it is important to inform the match data (description, date and goalkeeper under evaluation). During the match it is possible to record the actions performed by the goalkeeper, as well as querying the partial results.

Notice that the goalkeeper is the focus of the evaluation. Hence, when he is substituted during a match, his participation is terminated and the evaluation needs to be finished. In order to evaluate the goalkeeper that replaces him, it is necessary to initiate a new evaluation and inform

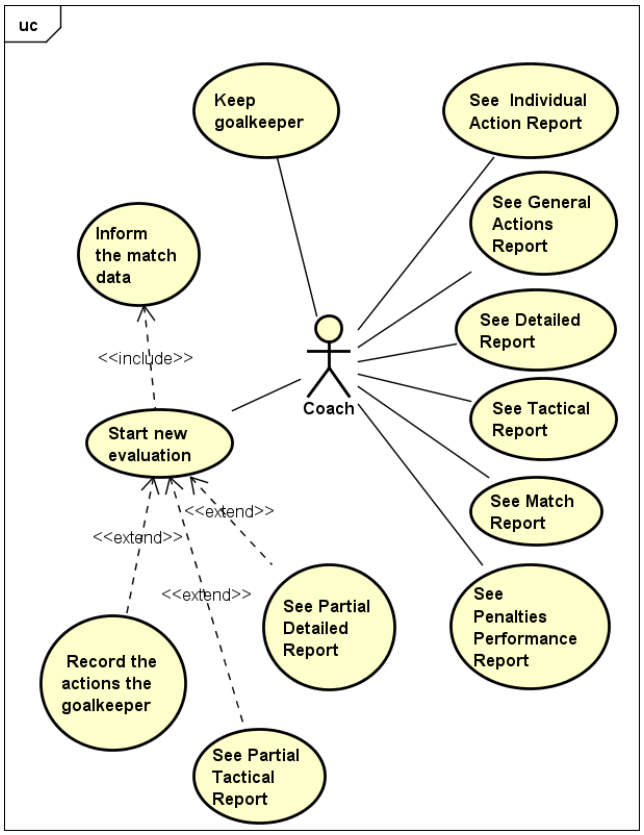


Fig. 5. Use cases Diagram for *Goalkeeper*

the match data. The system will not verify whether the match has the same date and description as one already existent, given that the matches serve only to group the plays under evaluation, offering an extra filter for some reports and a better organization of the recorded data.

The partial results are available during an evaluation and are important for the formulation of strategies performed during a match. Those results refer to tactics (partial tactic report, which shows as a graphic, the amount of the opponent plays in each sector of the field) and to actions (partial detailed report, which show the details of each play, offering a complete description of each play in textual format).

The reports concerning finished evaluations are: penalties performance report (shows the number of defended and undefended penalties, as well as those that never reached the goal), match report (all the matches in which the goalkeepers participated, containing links for the tactic and detailed report for each one of them), general actions report (graphic representing all the actions and the respective occurrence of errors and saves) and individual action report (shows for each action, the number of occurrences and the percentage of correct and incorrect actions).

The diagrams presented were created with the IDE *Astah Community*, which, according to Lahoud et al. [10], is a software for data modelling using the UML language.

IV. Implementation

The system was built according to the requirements described above. It is compatible with the Android operating system, used in mobile devices, such as tablets and smartphones. According to the parameters defined in the mode, we first implemented the graphical user interface and, then, the routines.

The implementation of the graphical user interface followed the standard defined by *Material Design*, a guide developed by Google to standardize the design of Android applications. It is possible to read those standards at Lecheta [11].

One of the components established by *Material Design* is the *Navigation Drawer* menu. It works as a drawer which encompasses the whole screen height and slides from left to right showing all the possible destinations in an application. In this menu, we added three options for the user: navigate for goalkeeper record storage, initiate an evaluation or seek information on the application. According to Figure 6, the menu is inserted into the application initial screen.

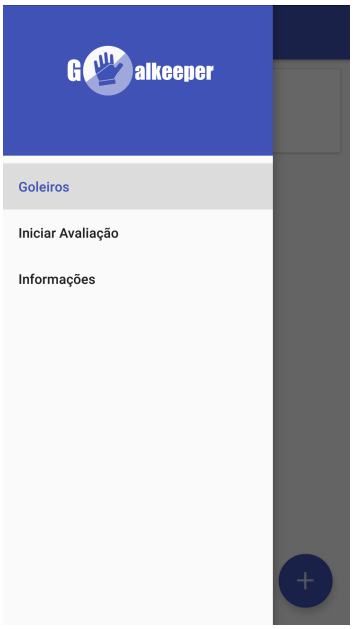


Fig. 6. Initial screen of the *Goalkeeper* application with the *Navigation Drawer* open.

Another pattern suggested by *Material Design* is to use the floating action button. This button looks like an encircled icon floating above the interface. When pressed, it can promote an action (usually, the main action in the screen). It was used to represent goalkeepers registration in the application. In all screens where there are registrations, the floating button becomes evident. floating over the interface.

The screen which presents the list of goalkeepers, shown in Figure 7, has a floating action button, located in the lower right corner. When clicking on the button, the user is redirected to the screen where he can register a goalkeeper.

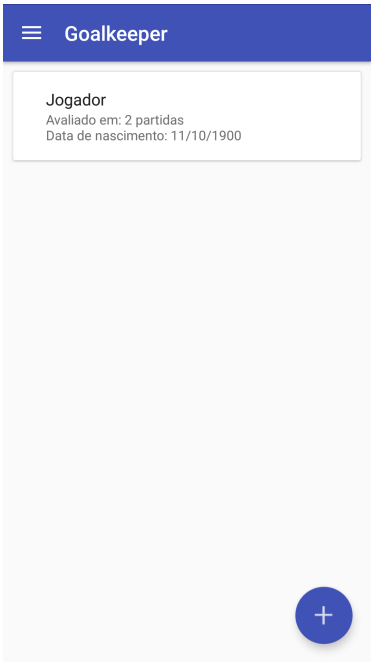


Fig. 7. Screen which lists goalkeepers in the *Goalkeeper* application.

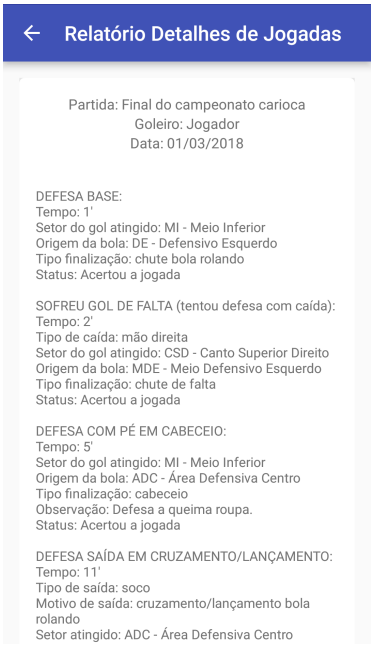


Fig. 8. Detailed report

We implemented the routines using the relational database SQLite to persist the application data. According to [11], SQLite is a powerful, yet light database supported by Android. The necessary APIs to execute scripts, create tables and fill data are available in the package "android.database.sqlite". The database scheme is similar to de class diagram described in Section III, making each class correspond to an entity in the database.

Report generation is made based on queries on the database, with whom we can generate both textual (match reports and detailed reports) and graphical reports.

The match report lists all matches in which the goalkeeper played, offering access to the tactical and detailed report for each match. The detailed report, on the other hand, displays the details of each recorded match. It can be generated both in its partial version (during a match) as well as in its final version (after the game is ended). Figure 8 shows a detailed report generated in its final version.

The graphical reports are generated with the help of the *MPAndroidChart*, made available by Jahoda [8]. According to Satish et al. [15], this libraries allows for a great variety of graphics inside an Android application. The data returned by the SQL queries are given to the *MPAndroidChart* library. Then, it is possible to generate several types of graphics and reports: tactical report (horizontal bar graphic), penalty performance report (vertical bar graphic), general action report (graphic in radar shape, concentrating all actions) and individual action report (each action is inserted into a sectors graphic).

The tactical report allows us to identify from which field sectors came the plays that caused the goalkeeper's actions and an example of such a graphic can be seen in Figure 9.

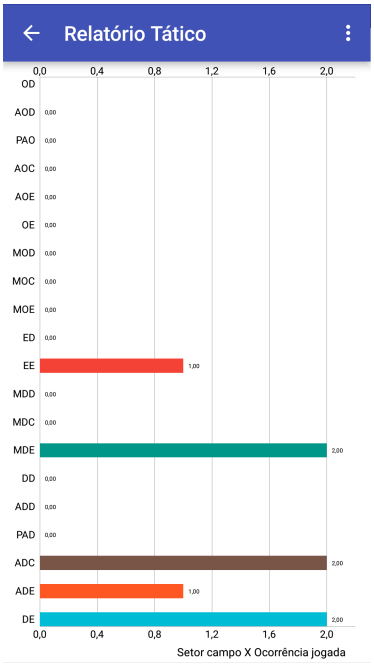


Fig. 9. Tactical report of one match evaluated using the *Goalkeeper* application.

The field sectors listed in Y-axis of the graph in Figure 9 are: DE - Left Defensive , ADE - Left Defensive Area, ADC - Central Defensive Area, PAD - Defensive Small Area, ADD - Right Defensive Area, DD - Right Defensive, MDE - Left Defensive Middle, MDC - Center Defensive Middle, MDD - Right Defensive Middle, MOE - Left Offensive Middle, MOC - Center Offensive Middle, MOD - Right Offensive Middle, OE - Left Offensive, AOE - Left Offensive Area, AOC - Center Offensive Area, PAO - Offensive Small Area, AOD - Right Offensive Area, OD - Right Offensive, EE - Left Corner, ED - Right Corner.

Hence, in Figure 9, it is possible to realize that most actions came from the defensive area.

An example of Penalties Performance Report is shown in Figure 10. This reports considers penalties that occurred in all evaluations. In the case depicted in Figure 10, no penalty was defended, one turned into a goal and one did not reach the goal.

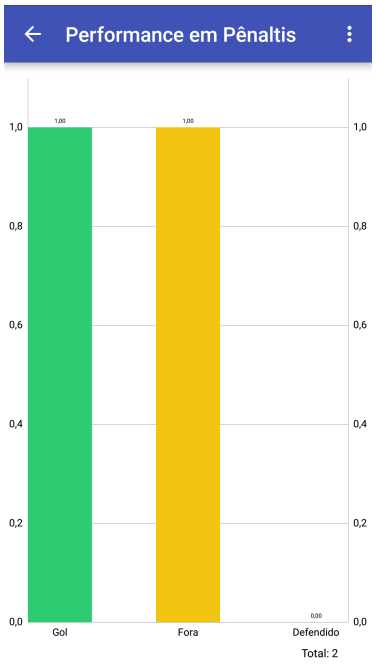


Fig. 10. Example of a Penalty Performance Report generated by the *Goalkeeper* application.

The general actions report offers a percentage of correct and incorrect actions for each type of action performed by the goalkeeper. Its goal is to allow the instructor to identify the weak and strong points of each player. The percentage of correct actions is represented in blue and the percentage of errors is represented in red. In the example of Figure 11, it is possible to see that the goalkeeper has a 100% success rate in defenses with his fist and with ball repositions, both with hands and feet, but misperformed in game restarts, headshots defenses and ball control.

The individual actions report complements the general actions report, given that the former does not inform the number of times an action was performed, only the percentage of correct and incorrect actions. In the individual actions report it is possible to see the frequency of execution for each action, as well as the percentage of correct (in blue) and incorrect actions (in red). Figure 12 shows an example of an individual action report. It is important to notice that being able to identify each individual action makes it easier to analyze a specific action.

V. Evaluation

When the development was finished, the system was shown to potential users in order to be evaluated. In this section, we describe the evaluation process and present an analysis of the results found.

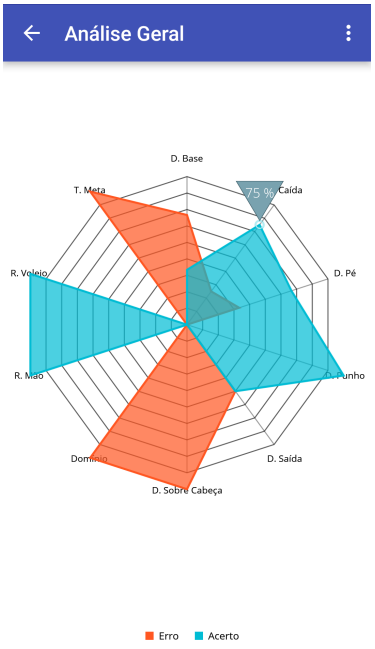


Fig. 11. Example of General Actions report generated by the *Goalkeeper* application.

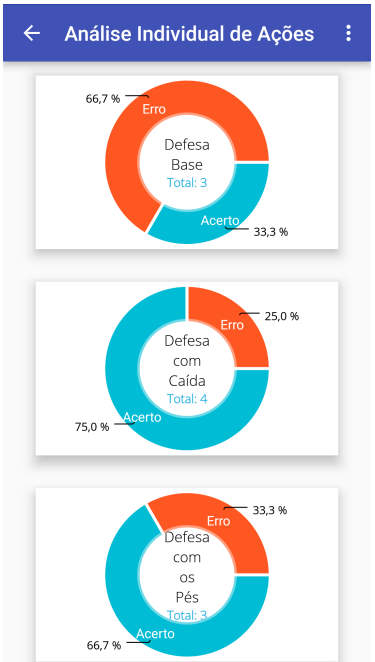


Fig. 12. Example of an Individual Actions Report generated by the *Goalkeeper* application.

A. Goal

The goal of this evaluation is to identify how well the *Goalkeeper* application is accepted by potential users, given that we do not know any other scout software for goalkeepers evaluation that is compatible with mobile devices.

The evaluation was made with a group of nine physical education professionals. Given the small number of participants, it was characterized as a relevant source at a small

execution cost.

B. Methodology

The evaluation model was based on TAM (Technology Acceptance Model). According to Davis [5], TAM offers grounds for acceptance or rejection of a technology based on two aspects: ease of use and usefulness. The ease of use explains how well a person considers simple and comfortable to use a specific technology. Usefulness, on the other hand, refers to how relevant using that technology would be to increase her performance in a specific activity.

TAM has been used in similar works, such as the one proposed by Ritter e Rigo [13], whose experiment was the foundation for the evaluation used in this paper.

Hence, for this evaluation, we selected by convenience a sample of nine physical education professionals, among them soccer experts.

Just like in the work of Ritter e Rigo [13], the small number of participants, in spite of not achieve highly trustworthy results, has a more accessible costs, allows for fast and introductory results. Hence, it is possible to react quickly to the results and increase the productivity of posterior evaluations which may be more complex and involve a larger number of participants and a higher execution cost.

Initially, we presented the system's goals and its functionalities. Next, we proposed the execution of four tasks in order to evaluate the system: 1 - store a goalkeeper in the database; 2 - evaluate a goalkeeper; 3 - see performance reports of the evaluated goalkeeper; 4 - see match reports of the evaluated goalkeeper.

The data to store and evaluate a goalkeeper in tasks 1 and 2, respectively, were obtained from a video from a match from a game which occurred in 2011 between two teams form the Brazilian first division. This match was chosen because it contained a lot of actions from a goalkeeper from one of the teams during the first half, allowing for data insertion for the generation of reports in a short amount of time - 46 minutes (45 from the first half plus one minute of extra time).

After evaluating the goalkeeper in the match, the users performed tasks 3 and 4, in which it was possible to analyze the results for that player.

After performing the tasks, we submitted a questionnaire with 6 questions. The first five refer to the following demographic data: sex, age, instruction level and familiarity with mobile devices.

The last question contains ten sentences. Sentences 1 through 5 refer to the ease of use of the system and sentences 6 through 10 refer to the evaluation of the perceived usefulness.

Sentences concerning ease of use:

1) The system is easy to understand.
2) The system is easy to use.
3) It is ease to query the reports and goalkeeper data.
4) It is easy to store the goalkeeper actions during a match.
5) The functionalities are clear and objective.

The sentences concerning perceived usefulness:

6) The system functionalities are relevant.
7) The system would make it easier to store goalkeeper actions.
8) The system would make it easier to analyze a goalkeeper's weak and strong points.
9) The system would make my work easier.
10) I would use this system would I be given access to it.

The sentences were evaluated according to the Linkert scale Likert [12], which offers the following five levels of agreement as options: 1 (Totally Disagree); 2 (Partially Disagree); 3 (Neutral); 4 (Partially Agree); and 5 (Totally Agree).

C. Participants profile

The demographic data were used to identify the participants profile (as seen in Table I).

TABELA I
DISTRIBUTION OF THE SAMPLE RESPONDENTS ACCORDING TO DEMOGRAPHIC CHARACTERISTICS AND FAMILIARITY WITH SMARTPHONES (N=9)

Variable	n	%
Sex		
Male	7	77,8
Female	2	22,2
Age (years)		
18 a 25	2	22,2
26 a 33	4	44,5
34 a 40	2	22,2
40 ou +	1	11,1
Instruction level		
Undergraduate student	-	-
Undergraduate	3	33,3
Graduate Student	3	33,3
Graduate	3	33,4
Has a smartphone		
Yes	9	100,0
No	-	-
Uses the smartphone as a tool to aid in work chores		
Yes	8	88,9
No	1	11,1

The proportion of men and women among the 9 participants was 77,8% and 22,2%, respectivamente. In terms of age, the age group from 26 to 33 years had the most participants (44,5%). As to instruction level, we could notice that most participants is either an graduate student (33,3%) or a graduate (33,4%). We could also notice that the participants were very familiar with smartphones, given that all of them owned one of such devices and 88,9% use it in work related activities.

D. Results

Table II presents the results found with the application of the evaluation questionnaire concerning the sentences

on ease of use. Table III, on the other hand shows the results for the sentences concerning usefulness perception.

As shown in Figure 13, the found positive results both for ease of use, where 95,5% agreed either totally or partially, as to the usefulness perception, where 93,3% agreed either totally or partially.

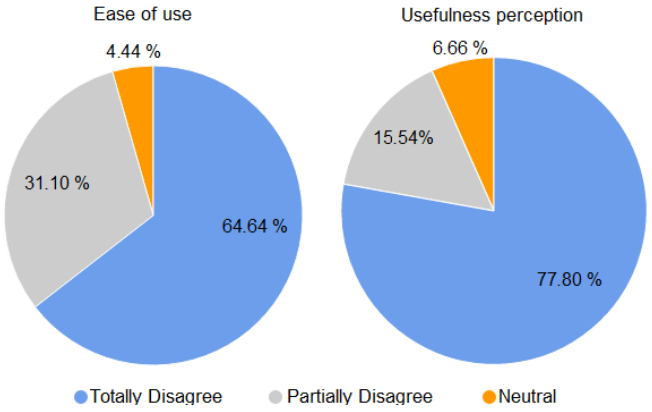


Fig. 13. Results for ease of use and usefulness perception

The agreement level with each of the ten sentences is shown in Figure 14. In the vertical axis, we show the resulting values of the arithmetic mean of the answers. In the horizontal axis, we show the sentences, listed according to the numbers defined in subsection V-B.

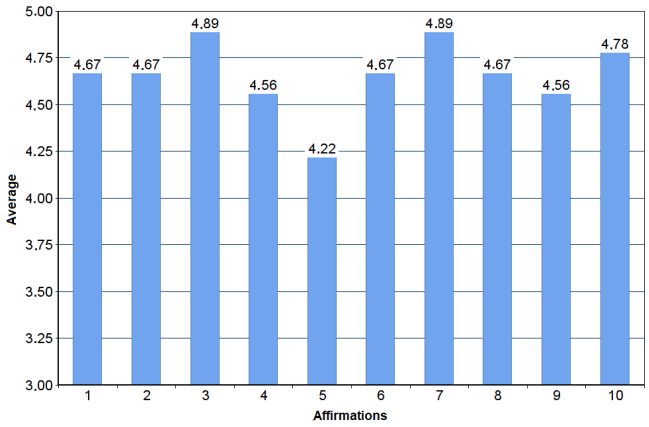


Fig. 14. Comparison of the sentences.

E. Analysis

Analyzing the graphic in Figure 14, it is possible to notice that all ten sentences were positively evaluated, because the average values ranged from 4,22 to 4,89, which, according to the Linkert scale, consists either in partial (4) or total (5) agreement.

Agreeing with Figure 14, Figure 13 shows the average of the sentences, which amounted to an agreement rate above 94%. We would also like to highlight that total agreement was chosen twice as much as partial agreement, in the case of ease of use and, in the case of perceived usefulness, five times as much. Besides, no participant came to disagreement with any of the sentences.

Hence, we can come to the conclusion that the acceptance levels for both ease of use and system usefulness are promising and also that a strong suit of *Goalkeeper* is its usefulness.

Tables 1 and 2 also showed that user acceptance happened in a mostly positive way. It is important to notice that in all sentences the rate of total agreement was higher than the rate of partial agreement, except for sentence 5, with which 55,6% of the participants agreed partially, the neutrality rate was 11,1% and the total agreement rate was 33,3%.

Even though it received a positive rating from the users, sentence 5 did not achieve the same acceptance level as the other sentences. Hence, functionalities clarity and objectivity are inherent characteristics of the system, but in a smaller way. Besides, this reinforces the conclusion that, in general, the system is more useful than easy to use.

In spite of that, if we observe Figure 10, it is possible to see that the ease of use is a strong suit when we are talking about using the goalkeeper's evaluation reports, given that the sentence 3 received an average of 4,89, which is the highest recorded average.

Just like sentence 3, sentence 7 received the highest recorded average. Hence, the practicality offered by *Goalkeeper* to record the plays in which the goalkeeper participated in the usefulness characteristic which was better accepted by the participants.

F. Threats to validity

The results found may be considered promising for ease of use and system usefulness. In spite of that, it is important to point out that the number of participants was quite small, a single goalkeeper was evaluated and we only considered the first half of a match.

This way, the evaluation performed shows only initial results, but was based in a consolidated evaluation model and offered positive results.

One possibility to find results with higher trustability is to replicate the performed evaluation with a higher number of participants, which would evaluate more than one goalkeeper during whole matches.

VI. Comparative Analysis

The acceptance of *Goalkeeper* by potential users was easy to perceive. The application included all evaluation items included in the subsection II-A, was built for the *Android* platform and is able to generate graphical and textual reports on the scout data gathered.

Table IV shows the main differences between *Goalkeeper* and the softwares described in the subsection II-B. It is possible to notice that *Goalkeeper* offers adequate support to evaluate goalkeepers, because it encompasses all evaluation items described in the subsection II-A. The other softwares include those items partially, being more appropriate for the evaluation of outfield players.

TABELA II
RESULTS CONCERNING EASE OF USE

Ease of use	**Totally Agree**	**Partially Agree**	**Neutral**	**Partially Disagree**	**Totally Disagree**
1 - The system is easy to understand.	66,7% (6)	33,3% (3)	0,0% (0)	0,0% (0)	0,0% (0)
2 - The system is easy to use.	66,7% (6)	33,3% (3)	0,0% (0)	0,0% (0)	0,0% (0)
3 - It is ease to query the reports and goalkeeper data.	88,9% (8)	11,1% (1)	0,0% (0)	0,0% (0)	0,0% (0)
4 - It is easy to store the goalkeeper actions during a match.	66,7% (6)	22,2% (2)	11,1% (1)	0,0% (0)	0,0% (0)
5 - The functionalities are clear and objective.	33,3% (3)	55,6% (5)	11,1% (1)	0,0% (0)	0,0% (0)
Média	64,64%	31,10%	4,44%	0,00%	0,00%

TABELA III
RESULTS CONCERNING USEFULNESS PERCEPTION

Perceived usefulness	**Totally Agree**	**Partially Agree**	**Neutral**	**Partially Disagree**	**Totally Disagree**
6 - The system functionalities are relevant	77,8% (7)	11,1% (1)	11,1% (1)	0,0% (0)	0,0% (0)
7 - The system would make it easier to store goalkeeper actions	88,9% (8)	11,1% (1)	0,0% (0)	0,0% (0)	0,0% (0)
8 - The system would make it easier to analyze a goalkeeper's weak and strong points	66,7% (6)	33,3% (3)	0,0% (0)	0,0% (0)	0,0% (0)
9 - The system would make my work easier.	66,7% (6)	22,2% (2)	11,1% (1)	0,0% (0)	0,0% (0)
10 - I would use this system would I be given access to it	88,9% (8)	0,0% (0)	11,1% (1)	0,0% (0)	0,0% (0)
Média	77,80%	15,54%	6,66%	0,00%	0,00%

TABELA IV
COMPARISON BETWEEN THE STUDIED SOFTWARES AND *Goalkeeper*

Resource	*Goalkeeper*	Spreadsheets + SDIS & GSEQ	Grêmio FBPA	Soccer Scoop + Goalie Viewer
Inclusion of items of subsection II-A in the evaluation	All	Partial	Partial	Partial
Support to mobile devices	Yes	No	No	No
Graphical reports	Yes	No	Yes	Yes
Textual reports	Yes	Yes	Yes	No
Evaluation of outfield players	No	Yes	Yes	Yes

On the issue of execution platform , *Goalkeeper* is the only one developed for mobile devices. This makes its use during a live match more pleasant. Besides, it follows the technological trend described by Turban e Volonino [18].

The reports generated by *Goalkeeper* and by Grêmio FBPA encompass the graphical and textual types. In all the others, only one of the options is offered. This make the former two more complete tools to evaluate the gathered data.

VII. CONCLUSION

This work presented a goalkeeper evaluation system, aimed at professionals in the area of physical education and soccer goalkeepers instructors. The goal is to perform the complete evaluation of the goalkeeper through scouting within an application that runs on widely used mobile devices, such as Android smartphones and tablets.

This work is relevant and presents a system able to support a coach during the evaluation and the creation of specific practices for their athletes. The *Goalkeeper* offers statistical reports generated through evaluation data gathered during matches, practices or videos.

The evaluation showed that the system was satisfactorily accepted by the professionals in the area of physical education. In spite of the fact that the number of participants was small (nine persons), the initially proposed goals were reached. Nevertheless, it is important to point out that evaluations with more participants are necessary to find degrees with a higher level of trust.

This study offers some opportunities for future work, such as the possibility to perform evaluations with goalkeepers coaches in live matches. These evaluations could encompass a larger number of participants, in order to measure the efficiency of the application in improving the coach's decision making process, as well as in making in clear the need to insert new goalkeeper actions for evaluations. Besides, it would be interesting if the *Goalkeeper* worked as a distributed application, offering data integration with other softwares, specially in softwares for the evaluation of outfield players, allowing for the alignment between the general coach and the goalkeepers' coach concerning the information on the athletes.

Finally, there is the possibility to make the software compatible with other platforms, such as the Web platform

(making it possible for any Internet connected device to use the software) and with the Apple platform (*iOS* smartphones).

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