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THE ADVANCEMENTS AND USE OF TECHNOLOGICAL STRATEGIES IN PERFORMANCE ANALYSIS OF SOCCER: AN UPDATE

MOHAMAD RAZALI ABDULLAH[1], RABIU MUAZU MUSA[1*], NORLAILA AZURA KOSNI[1], AHMAD BISYRI HUSIN MUSAWI MALIKI[1], PATHMANATHAN K. SUPPIAH[2]

[1]*Faculty of Applied Social Sciences, Universiti Sultan Zainal Abidin, Terengganu, MALAYSIA.*
***Email:** rabiumuazu86@gmail.com*
[2]*Faculty of Psychology and Educational Studies, Universiti Malaysia Sabah, Sabah, MALAYSIA.*

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ABSTRACT

Performance analysis in the game of soccer involves the collections of series of data based on relevant performance indicators on player's performance to aid accelerate his development. The development of technological devices in performance analysis of soccer began from manual notation system to different sort of devices which ranges from simple to complex each having its own advantages and shortcomings. The purpose of this paper is to review the technological advancement in the performance analysis of soccer. Three significant improvements were discussed highlighting the contribution as well as the limitation of each system in the performance analysis of the game. Hand notational systems, tablet application systems, as well as computerized video analysis systems, were deliberated. Although each of the system used has its own contribution in the provision of feedback to improve performance, computerized video analysis system is considered to be the best in providing information for assisting the coach to improve both individual and team performances.

Keywords: *Hand notation system, performance analysis, soccer, tablet application, technological devices, video analysis.*

1. INTRODUCTION

Performance analysis is a branch of sport and exercise science that focused on the factual performance of an athlete instead of estimation or self-report by the

Correspondence: Rabiu Muazu Musa, Ph.D. Student, Faculty of Applied Social Sciences, Universiti Sultan Zainal Abidin, Terengganu, MALAYSIA, Tel: +601121029823, Email: rabiumuazu86@gmail.com

athlete, coach or a spectator (O'Donoghue, 2010). Carling, Williams, and Reilly (2005) described performance analysis in soccer as the appraisal of the team or player's performance in which significant variables are designed to gather information from a competitive circumstance utilizing either hand, video camera, programming applications or computer to decide activity of player, his position, time and result in either success or fail. Performance analysis is often utilized in numerous sports to enable coaches to obtain objective information that can be used to deliver feedback on performance. Moreover, Travassos, Araujo, Correaia, and Esteves (2010) reveal that performance analysis in soccer is commonly regarded as a purposeful arrangement of data from players' performance compiled in an extensive report format aimed at enhancing his development.

The performance analysis here in discussed comprises of application of skills, movement pattern, decision making as well as physical performance. Moreover, Benjamin, (2002) stated that the primary function of performance analysis in soccer is to provide the coach with information about team or individual's performance which can enable the coach to have accurate, objective, and relevant feedback to be available for players. Nonetheless, in order to accomplish this task, the coach must take into account what has happened in a recently completed performance and be able to ascertain how this performance fits into the pattern of accumulated performances over the season (Hughes, 1996). However, there is some resistance to its use. This resistance is based on the traditional view that experienced coaches can observe a match without any aid to the observation process and report accurately to the players on the critical elements that have determined the outcome (Hughes, 1996). But in contrast, researchers in sports and everyday settings have clearly indicated that such observations are not only unreliable but also inaccurate. Franks, and Miller, (1986) reported that traditional coaching involves subjective assessment and conclusion based on the coach's opinion, biases and his prior experiences. However, Hughes, and Franks, (2008) observed that coaches and spectators often easily recall important portions of competition such as a controversial decision, spectacular performances while other none-critical events are most likely forgotten. This form of prejudices, when mixed with emotions and personal bias of the observer, may cause inaccurate and misleading information about the game. For this reason, a collection of information that is unbiased, objective and meaningful could be obtained via performance analysis. However, it should be noted that although, performance analysis is objective and unbiased, some sports may require subjective analysis in the form of observational judgments on the outcome of the athletes' overall performance with a view to bridging the gap in the general performance analysis procedure.

The history of performance analysis in soccer can be traced as far back as the 1950's, and 1960's when Reep and Benjamin in 1968 recorded and analyzed

data from 3213 matches between 1958 and 1968 (Hughes, & Franks, 2008; Yamanaka, Hughes, & Lott, 1993). The crucial improvement in soccer performance analysis was put forward by Franks, (1983) when he examined the 1982 World Cup. Likewise, Franks, and Miller in 1986 utilized an options computerized notation system through which six Liverpool's matches were investigated amid the 1985-1986 season using a concept keyboard (Hughes, & Franks, 2004). Nowadays, the use of computers, videotapes, and digital cameras are widely recognized to monitor and evaluate the performance of a team or a player in a soccer match (Carling, *et al.*, 2005). In addition, Hughes, and Bartlett (2002) reported that in a higher soccer league, eight cameras are set up around the stadium that allows all the twenty-two players on the field to be tracked. The data are then sent to the clubs for an in-depth analysis to be carried out on the performance of the team or an individual player.

With the recent technology advancement for example game analysis software, it befitted promising to enhance the gathering of performance data in real time both in competition and training with the aim of improving the performance of a player (Araujo, Davids, & Hristovski, 2006). Providing feedback on performance in soccer is reported to play a significant role in improving the overall performance of a player (Hook, & Hughes, 2001; Hugo, *et al.*, 2014). The effect of technological advancement in enhancing the level of performance in the sport of soccer can't be over underlined. Coaches have committed themselves looking for the best innovation gadget to help with their day to day preparation and amid competition. The improvement started from manual documentation system to various kinds of devices which range from easy to complex each having its particular favorable circumstances and weaknesses. This is why this study was undertaken to review the innovative progression in the performance analysis of soccer.

2. METHODS AND MATERIALS

An Overview of Performance Analysis Systems

2.1 Manual Notation System

In a soccer game, the initial performance analysis system was established by Reep, and Benjamin in 1968 when he analyzed the game using paper and pencil (Hughes, & Franks, 1995). However, O'donogue, (2007) reported that shorthand notations systems have been utilized for centuries to record information in diverse areas of sports as well as music. The most fundamental studies carried out applying manual techniques were completed by Reep, and Benjamin in 1968 and Reilly, and Thomas in 1976. Reep, and Benjamin in 1968 accomplished a 25-year

analysis of the chance of scoring from possessions of different numbers of passes, using data from English League soccer matches played between 1953 and 1968. Similarly, Reilly, and Thomas in 1976 developed manual techniques to approximate distance covered and work-rate during top level soccer performance (Reilly, & Thomas 1976). Although, manual notation system is simple to use and requires less equipment's but is time-consuming and the amount of data generated by the system can involve many hours of time to process the information that can be meaningful to the coach, athlete or the sports scientist. It is pertinent, therefore, when developing a manual notation system, a greater consideration has to be given to the eventual results that are to be created and how the system can deliver information to make the production of the results as effective as possible. An example of a manual notation system for both team and individual analysis is shown in table 1 and 2 respectively.

Table 1: An illustration of manual notation sheet for team analysis

Performance Indicators	1st Half	2nd Half	Total
Successful passes back 1/3	//////	/////	11
Successful passes mid 1/3	//////	//////	12
Successful passes front 1/3	//////	///////	13
Turnover back 1/3	//////	////////	14
Turnover mid1/3	///////	/////////	16
Turnover front1/3	////////	//////////	20
Interception back 1/3	////////	////	12
Interception mid 1/3	//////////	///////	17
Interception front 1/3	///	//	5
Set pieces	///	//////	9
Fouls Committed	///////	/////////	15
Goals scored	/	-	1
Goals conceived	//	//	4
Total Number of Actions	**75**	**74**	

Table 1 projects an example of manual notation sheet for team analysis. The simple sheet enables the compilation and analysis of team performances during a match day. The figure contains four columns, the first one indicating the performance indicators which could be selected based on the need for the coach. Thirteen performance indicators are selected here and shown as an example. The second column contains first half which refers to the record of all the actions performed by the players in the first half interval of the match. The third column indicates the second half actions while the last column reveals the total actions accumulated for both the first half and second half period. The analysis is carried

out by putting tallies based on the performance indicators observed as the match progresses. At the end of the match, a total record of all the performances of the team can be generated as shown in the figure.

Table 2: An illustration of manual notation sheet for individual player analysis

Name of Player								Team					Position	
Time	Location	Shots		Leg part		Type of shots				the outcome of the shots				Direction of shots
		On	Off	Right	Left	Drive	Place	Header	Other	Goal	Saved	Blocked	Missed	

Table 2 reveals an example of manual notation sheet for individual player record of performance analysis. From the top of the sheet, the name of the player, the team and the position of the player is provided. A total of eight columns are provided which include time, location, shots, leg part, type of shots, outcome of the shots and direction of the shot. The time in the sheet refers to the period at which the player executes an action while the location indicates the exact place the action is performed. The shots from the sheet contain two variables on/off which refer to the final destination of the ball when the shot is launched, whether the ball goes on or off target. Similarly, leg part denotes to the leg utilized for the execution of the shot either right leg or left leg. The next column reveals the type of shorts which refers to the kind of shot the player performs and is classified as a drive, place header and other that could come up from a different style. The sixth column indicates the outcome of the shots which is represented by either goal, saved, blocked or missed. The column reflects the direction of shots which require a description on where the shot is directed.

2.2 Tablet Application Systems

The accessibility of various devices have further made notational analysis easier. With a variety of user-friendly smartphones and tablet application available, performance analysis result can be delivered to the coach in real time and hence become a significant tool in ensuring the success of athletes both at individual and team level. The following are some examples of tablets applications that offer the user opportunities to analyze player's performance.

2.2.1 Dartfish Easy Tag: Dartfish easy tag is an Android based application for national analysis in sports which can also be used with iOS. With Easy Tag, the notational analysis is made easy. The timer is set at the start of the game then an

entirely adaptable labelling panel is utilized to time-stamp the key performance parameters (KPP) of any selected game and show moment statistics of their frequencies. Easy Tag makes a .csv document which can be further investigated by spreadsheet programming or labelled occasions can be identified with a video recording by import into Dartfish video analysis programming (TeamPro and Connect+ versions). Easy Tag's panel can contain from 9 to 30 buttons each of which can be set to time stamp a settled, user characterized length of time which permits a single button tap to record an event. The buttons can likewise be set to be open duration which is ideal for recording the length as well as the frequency of stages of play. Similarly, the buttons can be named and shaded coded. Alternatively, the buttons can likewise show frequencies and have variable shading coding as indicated by recurrence, giving moment visual feedback on the selected KPP.

Figure 1: Screen shot of Dartfish Easy Tag installed on a tablet phone

2.2.2 StatWatch Application: StatWatch, is a tablet application for notational analysis developed by a chartered sports engineer based in Malaysia which is commercially available direct from the developer, is an application that is attuned with a tablet or cell phones. It can code the performance of two players in the meantime each with 20 accessible cells to key in the performance parameters for every player in a way that their performances can be examined simultaneously. In the wake of selecting and key in the performance parameters, the performance parameters of both the two players will show up on the screen of the tablet. The begin button can then be pressed. All the required parameters to be coded would be organized on the screen, so all that is required is to tap on the parameter, and it will be consequently recorded. The data recorded can be transmitted to the coach at the required interim of the match that implies that the data can be transmitted as quick as could reasonably be expected to the coach as the game advances. The application has two methods for transmitting data or information to the coach. The data can be transmitted by means of Bluetooth or Email. Toward the end of

the match, analysis and synopsis are given by the application. The number of activities performed by every player, the time the activities is executed, and also, the number of achievement or failure can be seen. Moreover, bar diagrams are displayed to project the performance of every player taking into account the performance parameters the players are evaluated on. Essentially, the data can further be transmitted to Microsoft Excel for additional in-depth analysis.

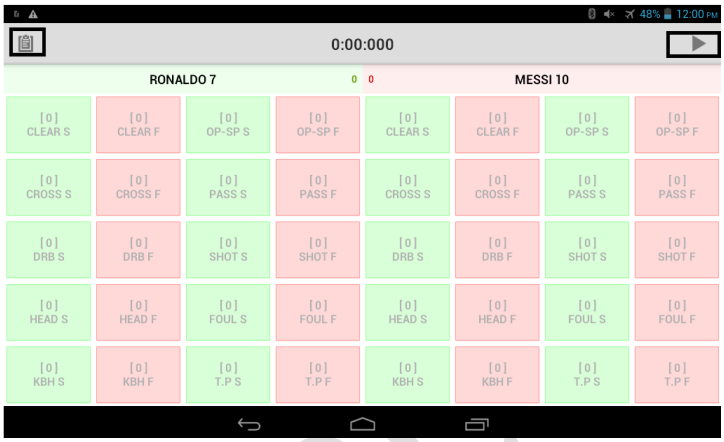

Figure 2: Screen shot of StatWatch application installed on a tablet phone

2.3 Video Analysis Systems

Video analysis is a distinctive and convincing method for introducing data, of highlighting fascinating trial discoveries, and of delineating unique ideas. It gives an exceptionally detailed, stable record which can be broke down from numerous points of view to extracting a variety of different types of information. These days, Video analysis is turning into an essential preparing instrument for many athletes, coaches, and trainers. The contemporary sports Competition today is steep, and teams and athletes require an additional edge (Dowrick, 1991). Video analysis in sports ought to convey details information on the performance of athletes over different systems and should contribute to quick adoption and widespread usage of multimedia services worldwide because sports video appeals to large audiences. Preparing of games video, for instance, recognition of essential events and making of summaries, makes it conceivable to convey sports video additionally over limited band systems, for example, the Internet and wireless, since the important actions largely occupy only a small portion of the entire content. The following video analysis systems are utilized by coaches to obtain objective information on the athlete's performance

2.3.1 LINCE: LINCE is a video programming application that is compatible with COMPUTER. It overcomes some of the insufficiencies of existing observational

projects, i.e. the requirement for monotonous activities, confinement in the video formats utilized, and the trouble of getting project licenses. To accomplish the yearning goal of overcoming these insufficiencies, the first vital features of LINCE is that it is free, with both the application and its code being straightforwardly released. Moreover, the documentation produced during advancement of the application is accessible under a Creative Commons BY-NC-SA permit. The application has been produced in Java in order to make it good with the current operating system. LINCE can be utilized to watch any scene of conduct since it has been built as a product bundle that mechanizes the elements of the outline of observational frameworks, video recording, and the estimation of information quality and the presentation of results which can be sent out in different formats (THEME, GSEQ, EXCEL, and SAS).

Figure 3: A screen shot of Lince analysis software

2.3.2 System Analysis of Player (S.A.P): System Analysis of Player (S.A.P) is a COMPUTER application that is attuned with window seven. It is intended to code the performance of two players or competitors concurrently. It has twenty accessible cells for the performance parameters that can be chosen based on the interest of the coach and the demand for the sport. The analysis is starting after setting the performance parameters in the cells by tapping the cell to record the actions in light of the performance parameters officially decided. There is a scoreboard on the screen of the COMPUTER that demonstrates the scores for every team or the player. At the end of the match or at the half-time interim of every match, a screenshot can be taken to transmit the data gathered to the player or the coach.

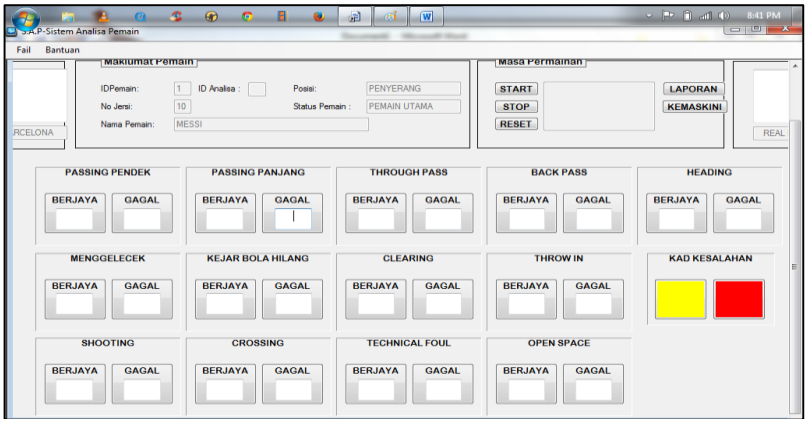

Figure 4: A screenshot of system analysis of player

2.3.3 Sports Code: Sports Code is a video analysis system that is developed to record and analyze games during both competition and training. The software is commercially available into three categories namely; Elite is Sportstec's head instructing program developed only for teams and individuals at the front line of sports performance. It is a definitive instrument for games performance recording, in-depth analysis, and individual player advancement. It is used during a performance for correlations and adjusting, then thereafter to coaches, players or teams with a complete database of video and factual statistical data. Sports Code Game breaker plus, on the other hand, is the perfect answer for coaches and competitors who need to make the first step outside tape-to-tape editing. Sports code enables the process of recording, playing, examination, editing, and utilization to accomplish the winning edge. Sports Code Player works like this. Performance data that has been recorded, gathered, edited and saved in Sports Code Pro or Elite is bundled into a document and transmitted to Sports Code Player. It's in a kind of "view only" format, which implies the record can't be adjusted or saved. However it can be read, and the data in it moved around to suit the necessities of the person.

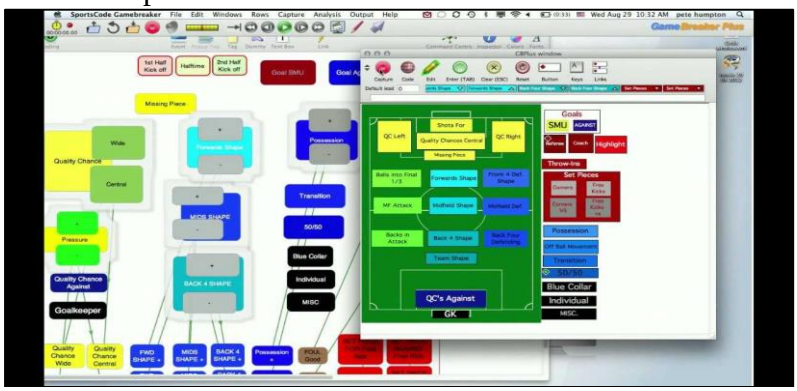

Figure 5: A screenshot of Sportscode performance analysis software.

2.3.4 Prozone: Prozone® is a computerized video system that allows the tracking of many individuals performing a sporting activity. It provides detailed team and opposition analysis. Prozone technology facilitates the comprehensive and objective evaluation of every aspect of performance. Currently, prozone performance analysis services provide over 350 clubs worldwide with tangible competitive advantage. Proven in 1995, Prozone has been pioneering performance analysis for 19 years. In 2011, Prozone and Amisco joined forces to create performance analysis industry with a strong combined vision. Amisco invented the technology and set the standard while; Prozone created the industry (ProZone® 2007).

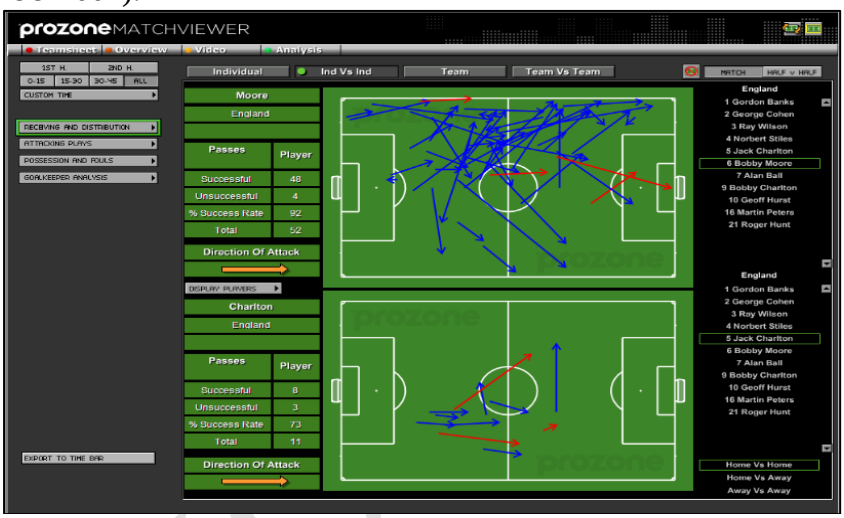

Figure 6: A screenshot of prozone analysis software.

3. RESULTS

Comparison of the Systems Abilities to Provide Information: Athletes and coaches need a powerful approach to support and guide the preparation process through the obtaining of objective information on performance by means of a reliable, solid as well as easy to understand tool (Baca, *et al.*, 2010). Lemmings, Morgan, Sampaio, and Saupe (2013) reported that for any instrument or gadget to be utilized for sports performance analysis, there is a requirement for it to be easy to use both during the time spent setting the parameters and transmitting the data to the athletes or coaches. Besides, Hughes and Bartlett (2002) inferred that the principal explanation behind performance analysis in soccer is to offer the coach and the players an input whereupon to base augmentative performance that is coordinated towards helping the players and the coaches to enhance their performance. Nevertheless, this could be accomplished efficiently when the device utilized for the gathering of performance information is reliable, accurate,

efficient and easy to understand. In this manner, feedback on performance could be gathered viably and transmitted through the utilization of a system that contains all the necessary features. Table 3 projects the comparative analysis of effectiveness for performance analysis between the three systems.

Table 3. Comparative analysis of the three systems

Features	Manual Notation	Tablet Applications	Video Analysis
Provides information in real time	*	✓	✓
Time efficient	*	✓	✓
User-friendly	✓	✓	✓
Provides an opportunity for playback	*	*	✓
Provide more accurate and reliable information	*	*	✓
Ease in data sharing and transmitting	*	✓	✓
Provide variety of features from the interface	*	*	✓
Enables analysis of multiple players at a time	*	*	✓
Enables the tracking of players movement	*	*	✓
Provides opposition analysis	✓	✓	✓

✓ Yes
* No

Table 3 provides comparative analysis on the essential features that are required for any performance analysis tool. From the table, it can be observed that manual notation system has the lowest advantage over the others due to the inability of the system to cater for most the features of a robust analysis tool. However, tablet applications systems have some advantages over the manual system because of its ability to providing some valuable information that manual notation system fails to provide. In another perspective, video analysis systems are shown to possess all the distinctive features of good performance analysis systems. As indicated by the table, video analysis systems have seemed to be a solution for performance analysis in soccer through the provision of answers to the current performance analysis challenges as well as the provision of any information a coach might require regarding players' performance.

4. DISCUSSION

O'Donoghue (2010) inferred that coaching procedure can be considered as a progressing cycle of performance and practice. The part of the coach is to watch and break down the performance and give input, which can be consolidated into

arranged practice that ought to hypothetically prompt to improved performance. Fruitful coaching depends, in addition to other things, on the exactness of the observation and how well it is dissected. It is, thus, critical that the data gathered amid athletic performance is objective, fair, exact and as far reaching as could reasonably be expected. Video analysis, a generally utilized device in modern sports and can give a training support to individual and group competitions. Coaches and trainers examine video from live action and preparation, and the results of their careful analyses deliver helpful feedback for the athletes. Moreover, with the help of video analysis, athletes can gain a competitive edge, correct faults and maximize their strengths. Injuries are a portion of every sport, but with the aid of video analysis, injuries and its reoccurrence can be prevented. Similarly, the technique the player use to run, dribbles, shot the ball or throw the ball occasionally is a contributing factor in sustaining an injury. With video analysis, therefore, careful examination of the proper technique can be carried out to pinpoint areas that must be changed to avoid injuries in the future. By watching video analysis of individual or team performance, a coach can discover weaknesses that may be holding the player back. A coach can choose an area in which the player is struggling and watch games or matches to find trends and patterns the player can change. For example, a soccer team may be vulnerable defensively on the outside; or a player may shots a ball consistently too far and wide on both his crossing delivery and shot on target. Once the fragile link is discovered, it can be modified and improved upon. Another way that using video analysis can help improve the performance of the player is to watch the best play of the game demonstrated by other professional players. Examining video of the best player at the same position with the player will display ways the player practices on a steady basis that help him succeed. When the player has pinpointed some of the techniques of the best players, he can work them into his own game. However, one of the most common ways video analysis is used is to prepare for upcoming events. Watching video of tomorrow's team or next week's opponent teaches the coach and the player their strengths and weaknesses, and thus, enables both the coach and the player articulate a game plan to deal with them. Mental planning is an important factor in any athletic event, so knowing what a player is up against earlier can give an extra advantage which video analysis can help to provide.

5. CONCLUSION

In any sporting circumstance, especially when team games are included, it is hard for coaches to see and recollect all the key occasions happening within a preparation session or in a game. In spite of a coach having the knowledge, vision and power of observation, either recollecting everything that has happened,

relying on recall or taking one's eye off the game to record the details, could render the information collected unreliable. The analysis that takes into account precise observation, recall and evaluation are a key instrument for enhancing future performance. The various performance analysis systems discussed in this paper are beneficial and convenient in performance analysis and provide information on the performance of both players and team as a whole. Although, manual notation system is simple to use and requires less equipment's but is time-consuming and the amount of data generated by the system can involve many hours of time to process the information that can be meaningful to the coach, athlete or the sports scientist. Tablet application can provide information to the coach in real time and is considerably time efficient, but could not give a chance for playback and the information generated could be prone to inaccuracy since the gathering of the information heavily depends on the individual observation. Video analysis is shown to be a distinctive and convincing method for introducing data, of highlighting fascinating trial discoveries, and of delineating unique ideas by taken sports performance analysis into the next step. It is currently recognized and utilized by some professional soccer clubs in the world to objectively analyze the performance of their players. Hence, there is a need for video performance analysis to be incorporated into the coaching system for any soccer club seeking for objective, reliable, accurate and effective delivery of information to help accelerate the development of the players as well as the progress of the team.

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