Paper : Game Analysis

Characteristics of Goal-scoring Crosses in International Soccer Tournaments

Hiroshi Yamada* and Yuta Hayashi*

*Faculty of Sport Studies, Biwako Seikei Sport College
1204 Kitahira, Otsu-shi, Shiga 520-0503 Japan
yamada-hi@bss.ac.jp

This study was confirmed the characteristics of goal-scoring crosses by location of attack and defense players in FIFA World cup 2010 and UEFA EURO 2012. We analyzed 64 goal-scoring plays involving a cross. The locations of crossers, receivers and three defenders against the crosses were recorded. Analysis of nine tactical items revealed the following factors in goal-scoring crosses: 1) crossers attempted to penetrate the side area to advance to the penalty area and cross by the goal line. In particular, when defense blocks were organized, players cut back crosses to around the penalty spot; 2) more than half of crosses were behind the defense line; 3) half of near-side crosses were concentrated in front of the near-post, and the remaining half were concentrated around the penalty arc; 4) receivers ran toward the front of the goal. In particular, receivers on the far-side cut into the PTA with diagonal or lateral movement; 5) early crosses usually occurred between the penalty spot and the goal area, behind the center of three defenders against the cross; and 6) in early crossing, the nearer the touch line was, the larger the lateral gap was.

1. Introduction

The trend in recent defense tactics in soccer is zone defense to create blocks. Defenders are positioned to prioritize spacing, with a particular emphasis on the space in front of the goal and the middle of the field. Although it is difficult to penetrate from the middle of the field, the available space is larger due to the relatively weak pressure on the side. Therefore, the side attack is an effective offense. In technical reports (UEFA, 2012b) on UEFA EURO (EURO) 2012, Gérard Houllier, Technical Director for the French Football Federation, described this tactical trend saying, "the response to the compact defensive blocks set up in central areas is to try to go round the sides " In addition, more teams have started using collective counterattacks starting from the stealing of the ball, which requires control of such counterattacks. Loss of the ball in the middle increases the risk of counterattack (Armatas et al., 2005); therefore, a number of teams focus their offense on the side to reduce the risk. As a result, 46% of the goals in open-play offense during EURO 2008 were made through counterattacks; however, the number decreased to 27% during the UEFA Champions League (CL)

2011/2012 (UEFA, 2012a). As described above, from the viewpoint of risk management, the importance of counterattacks on the side has increased. In EURO 2012, 25 (42%) of 60 goals in open play were offense goals from the side. Furthermore, heading goals increased significantly over the two previous EURO matches. The cross offensive tactic on the side remains an effective attack.

Crossing to the prime target area (PTA) is an effective way to score. The PTA is the 18.32 m wide rectangular area covering 7.32 m (8 yards) from the penalty spot to within 2 yards inside the goal area. Hughes and Franks (2004) reported that approximately four-fifth of all cross scores involved play in this area. Headed goals require brilliant delivery and great movement by receivers (UEFA, 2012b). In other words, accurate crossing in the PTA to the target player in the front almost free from defense is an effective way of increasing the probability of goal-scoring crosses. Meanwhile, the defending team should assign a defender to block crosses to the PTA. Defense measures against crosses in the PTA were taken during EURO 2008 (UEFA, 2008; 2012b). However, in CL2010/2011 and CL2011/2012, cutback was often used to counter

this defense measure, and the scoring rate increased (UEFA, 2011; 2012a). This tactic involves penetration of the side area to advance to the penalty area, and returning the last pass from near the goal line in the negative direction. For this reason, both attackers and defenders are employing tactics around the side, which indicates the need for a relative evaluation of the defense and offense tactics on both teams.

Partridge and Franks (1989a, 1989b) noted the following key factors in goal-scoring crosses: 1) the cross should be played (a) first time, where possible; (b) behind defenders; (c) past the near post; (d) without loft and hang time; 2) target players should be in position to contact the cross by (a) individual moves to get goal-side of the marking defender; (b) being as direct as possible; (c) not running past the near post to contact the ball; (d) always making an attempt to contact the ball; 3) supporting players should position themselves to (a) seal off the top of penalty area; (b) seal off the back-post area(not allow any ball to go through the back-post area); 4) crosses should not be taken from areas close to the corner flag. Instead, the crosser should dribble towards the goal and either win a corner or get into the penalty area and cross to a particular player.

In order to evaluate these key factors, it is necessary to conduct notation analysis of the points at which crosses are passed and received, and the positions of offense and defense players, including both the absolute and relative positional relation between defense and offense. Suzuki and Nishijima (2004) measured the relative positional relation between defense and offense to evaluate defensive tactics in soccer. Suzuki et al. (2000) examined the causal structure of shooting skill, and measured and evaluated offense movement to mislead defense players, such as moving off the mark and breaking the defense line in the finishing phase of a game. These studies facilitate the analysis of tactical action against crosses utilizing relative positional relationships between defensive and offensive players.

Few studies provide notational analysis of major factors in successful crosses in international tournaments, and no studies examine the positioning of offensive and defensive players in relation to the PTA and the location of crosses in recent years.

Therefore, this study was conducted to clarify the characteristics of offensive and defensive player positions in relation to goal-scoring crosses in FIFA World cup (World Cup) 2010 and EURO 2012

through notational analysis.

2. Methods

2.1. Samples

The subjects of this study were 64 goal-scoring plays occurring in World Cup 2010 and EURO 2012. Set-piece defense tactics place defenders in front of the goal, which differs significantly from the standard tactics. Therefore, we excluded direct crosses in set-piece defense from the subjects of this study. Set-piece defense after positioned players returned to normal positions after clearing the ball, etc. was included in the subjects.

2.2. Definition of Terms

This study defined the below-listed terms from the standpoint of crosses, and defensive tactics and action:

1) Cross: Delivery of a ball from the side of the pitch across to the front of the goal to provide a direct goal-scoring opportunity. Subjects of the analysis are both offense and defense against offense from the side. Therefore, this study includes cutback (a pass back from near the goal line) according to the classification of UEFA (20112b) as crosses. Meanwhile, crosses are clearly distinguished from diagonal passes (to the penalty area) and forward passes (through passes and passes to the goal side over the defenders).

2) Early Cross: A cross delivered 16.5 or more meters from the goal line.

3) Deep Cross: A cross delivered 16.5 or fewer meters from the goal line.

4) Crossing Point: The point in the pitch where a cross is delivered.

5) Crosser: The player delivering a cross.

6) Reception Point: A point in the pitch where an attacker receives a cross.

7) Receiver: An offensive player that receives a cross.

8) Defender against Crosses: Three defenders in the front of the goal preparing for crosses. In principle, a four-backs formation consists of two center backs, and a farther fullback, and a three-backs formation consists of three center backs. When leaving a position for transiting offense and defense, the defender against crosses is the player that covers the position. If defenders are

insufficient due to counterattack, two or one defenders play the role. The three defenders against crosses are called the near-side defender, middle defender, and the far-side defender, depending on their distance from the crossing point.

2.3. Data Recording

In this study, we recorded ball and player positions to analyze the crossing tactics of the offense and defense. We also recorded ball cross and reception points along with the points of the receiver and three defenders at the time crosses occurred. For recording, we observed matches broadcast on TV and recorded on a SONY model BDA-AT700 HDD. In order to minimize measurement error, we used reduced drawings of the pitch (Suzuki and Nishijima, 2002). All 64 plays were viewed and the data were recorded separately by two investigators with Japan Football Association coaching licenses and experience playing soccer. When a significant difference between the data recorded by these two individuals was noted, the matches were reviewed repeatedly until the difference was resolved.

2.4. Analysis Items

We analyzed the items shown below to measure the response of the offense and defense based on the recorded points of the ball, receivers, and defenders. **Fig. 1** shows the definitions of analysis items.

1) Player position in crossing: The origin was set at the middle of the goal line. The positions of crosser, receiver and three defenders against crosses were indicated by abscissa (x) and ordinate (y). Abscissa closer to the crossing point (near-side) was set as "negative" and the opposite side was set as "positive."

2) Receiver position when receiving: Indicated with an abscissa (x) and ordinate (y). The definitions of positive and negative follow 1 above).

3) Cross angle: The angle made by a line from the crossing to the reception point, and the goal line. When the ball moved parallel to the goal line, it was set as "0"; when the ball came closer to the goal line, it was set as "positive"; and when the ball moved farther from the goal line, it was set as "negative."

4) Lateral gap: Difference between the abscissa (x) for the near-side defender and the abscissa (x) for the far-side defender.

5) Depth of the defense line: The distance between the rearmost of the three defenders and the goal line.

6) Distance between the defense line and the reception point

7) Approach distance by the receiver: The distance between the receiver position in crossing and reception point.

8) Receiver approach angle: The angle made by the line from the receiver's position and the reception point, and a vertical line toward the goal line. When
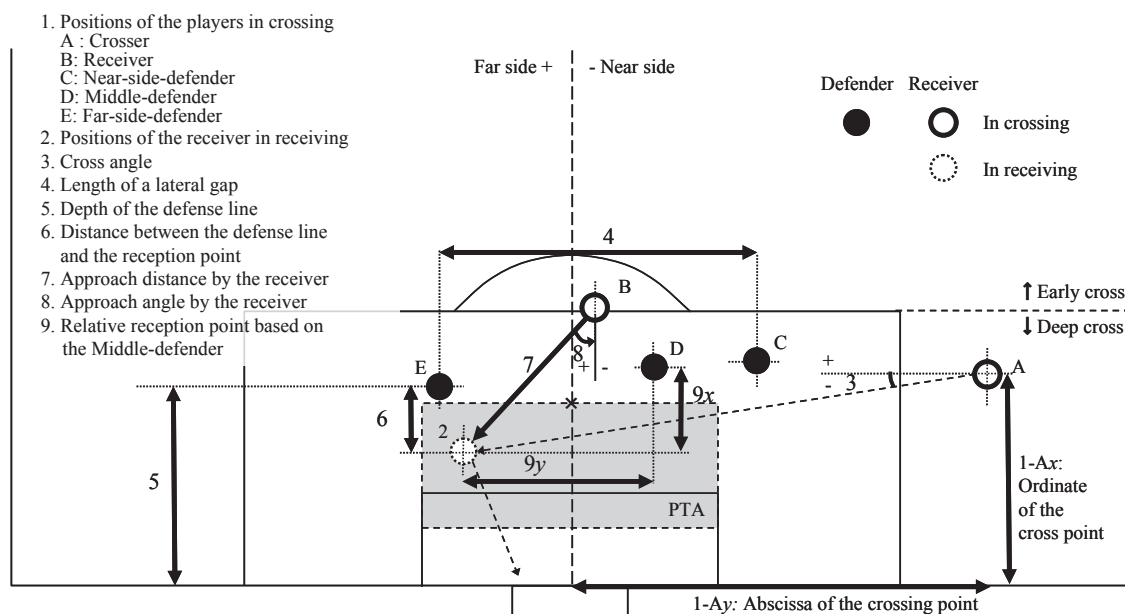

Fig. 1 Definition of analysis items.

the receiver moved vertically to the goal line, it was set as "0"; when the receiver moved to the near-side, it was set as "negative"; and when the receiver moved to far-side, it was set as "positive."

9) Relative reception point based on the middle-defender: Indicated with an abscissa (x) and ordinate (y) setting the middle defender in crossing as the origin.

2.5. Statistical Analysis

In order to examine the correlation among items, we calculated Pearson's product-moment correlation coefficient. In order to examine the variance in the reception point in early crossing and deep crossing, we conducted Levene's test for equality of variances. In order to examine the deviation in the reception point based on the middle defenders, we used Fisher's exact test. Statistical significance level was set at 5%. We used IBM SPSS Statistics 19 for all statistical analyses.

2.6. Inter-Rater Reliability

In order to confirm the inter-rater reliability for the recorded data, the two investigators involved in this study measured the same subjects to apply Pearson's product-moment correlation coefficient between data for the positions of the ball and players recorded.

3. Results

3.1. Basic Statistics and Inter-Rater Reliability

Table 1 shows the basic statistics of analysis items. Correlation coefficient obtained between the data recorded by the two investigators exceeded $r=0.8$ in all items. This confirmed inter-rater reliability for the recorded data in this study.

3.2. Distribution of Analysis Items and Correlation among the Items

Fig. 2 shows the abscissas and ordinates of the crossing points based on the unified crossing direction. For ease of understanding regarding the positional relations, we provided lines that indicate goal area, penalty area, penalty arc, and touch line. The obtained correlation coefficient among these was $r=0.51$ ($p<0.05$). The closer to the goal line the ordinate was , the closer to the middle of the goal the abscissa was.

Fig. 3 shows abscissas and ordinates for the reception point based on the unified crossing direction. Goal, goal area, penalty area, and penalty arc are indicated by solid lines, and the PTA is indicated by broken lines. Early crosses are indicated by black dots, and deep crosses are indicated by "x." Levene's test for equality of variances revealed a

Table 1 Basic statistics of analysis items (N = 64)

Items (unit)	average	SD	min	max	reliability
1 Positions of the players in crossing					
Ax : Abscissa of the crosser (m)	21.3	6.5	8.5	33.5	0.99
Ay: Ordinate of the crosser (m)	12.5	8.6	0.5	36.5	0.99
Bx: Abscissa of the near-side defender (m)	-0.6	4.6	-10.5	9.5	0.91
By: Ordinate of the near-side defender (m)	8.4	3.8	1.5	17.5	0.87
Cx: Abscissa of the middle-side defender (m)	9.0	5.5	0.5	26.5	0.84
Cy: Ordinate of the middle-side defender (m)	10.9	4.8	0	23	0.95
Dx: Abscissa of the far-side defender (m)	1.4	4.0	-13.5	11.5	0.85
Dy: Ordinate of the far-side defender (m)	11.2	4.5	2	25	0.94
Ex: Abscissa of the reciever (m)	-5.0	4.0	-21.5	2.5	0.98
Ey: Ordinate of the receiver (m)	12.9	6.3	0	32	0.93
2 Positions of the receiver in receiving					
2x: Abscissa of the reciever (m)	-0.6	4.6	-10.5	9.5	0.92
2y: Ordinate of the reciever (m)	8.4	3.8	1.5	17.5	0.97
3 Cross angle (deg.)	6.5	21.4	-47	50.7	0.98
4 Length of the lateral gap (m)	15.4	8.4	0	46	0.83
5 Depth of the defense line (m)	10.0	4.2	2	20	0.89
6 Distance between the defense line and the reception point (m)	-2.2	4.9	-11	12	0.92
7 Approach distance by the receiver (m)	7.0	3.4	0	13.5	0.89
8 Approach angle by the receiver (deg.)	8.7	31.0	-63	68	0.94
9 Relative reception point based on the middle defender					
9x : Abscissa (m)	2.0	6.3	-17	14	0.93
9y : Ordinate (m)	-3.3	5.1	-16	10	0.94

significant difference in equality variance of ordinates for the reception point in early and deep crossings (F (1, 62) = 6.51, P = 0.01). This indicates a markedly small vertical distribution of the reception point in early crossing.

Fig. 4 shows the abscissas for receivers in crossing and receiver approach angle. The obtained correlation coefficient between these was r = 0.52 (P < 0.05). This reveals that receivers on the near-side move away from the ball and receivers on the far-side move toward the ball when they run toward the front of the goal.

Fig. 5 shows the abscissas for receivers in crossing and receiver approach distances. The obtained correlation coefficient between these was r = 0.56 (P < 0.05). This reveals that the farther the receivers were on the far-side, the longer they moved.

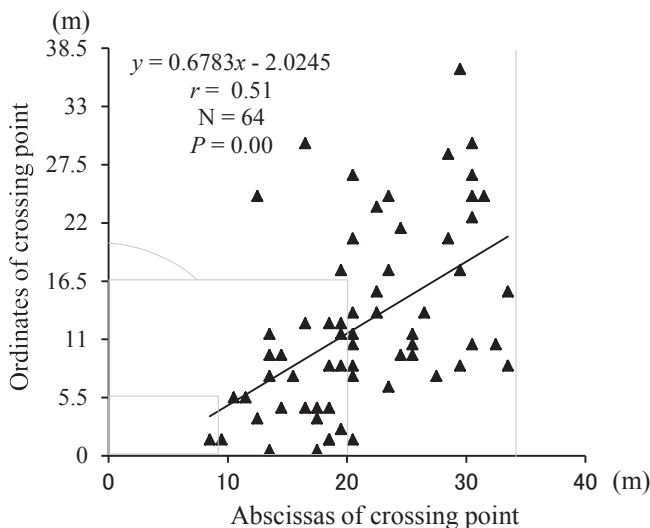**Fig. 6** shows the abscissas for defender crossing points and lateral gaps. Early crosses are inidcated by black dots, and deep crosses are indicated by "x." The obtained correlation coefficient between these in early crosses was r = 0.62 (P < 0.05). This reveals that crosses from the outside generate greater lateral gaps in early crosses while deep crosses did not show significant correlation.

Fig. 7 shows the abscissas and ordinates for the relative reception points based on the middle-defenders. The point where the middle-defender was in crossing was set at the origin to show the reception point. **Table 2** is a quadrant-specific cross tabulation of relative reception points based on the middle-defender. According to Fisher's exact test, more early crosses than deep crosses were seen in the fourth quadrant (p<0.05). This indicates that more early crosses than deep crosses were received on the goal side behind the middle-defenders.
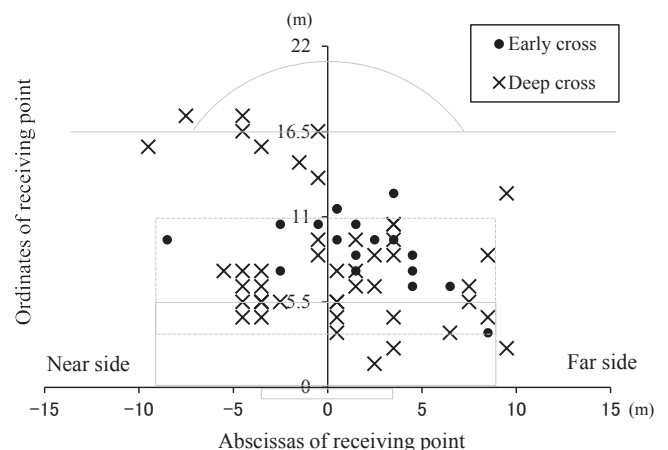

Fig. 2 Abscissas and ordinates of the crossing points.

Fig. 3 Abscissas and ordinates of the receiving points.

Fig. 4 Abscissas of receivers in crossing and approach angles of the receiver.

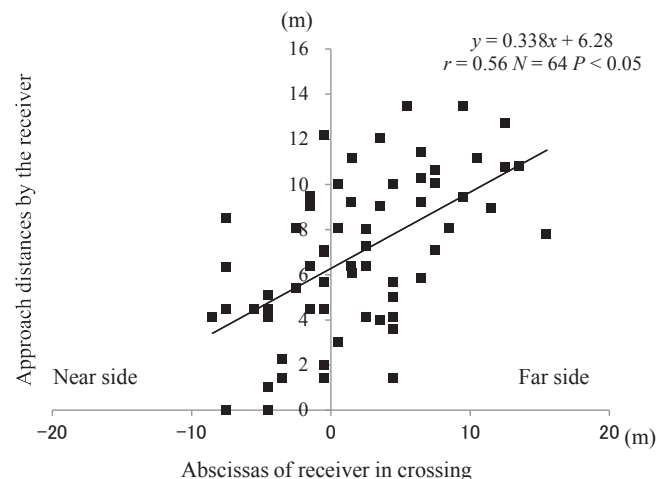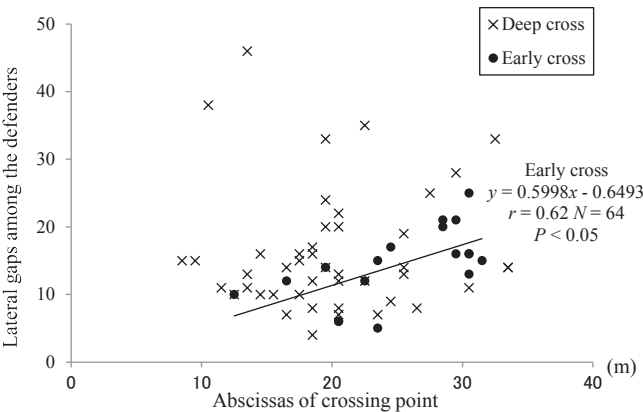**Fig. 5** Abscissas of receivers in crossing and approach distances of the receivers.

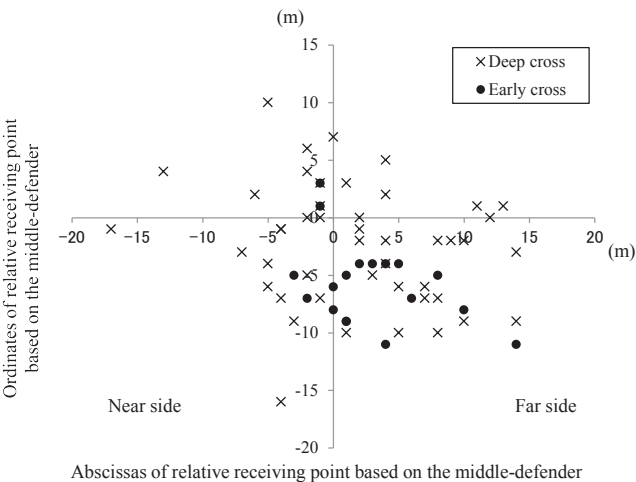**Fig. 6** Abscissas of crossing point and Lateral gaps among the defenders

Fig. 7 Abscissas and Ordinate of relative reception point based on the middle-defender

Table 2 Cross tabulation of relative reception point based on the middle-defender

			Abscissa		SUM
			Near side	Far side	
Ordinate	Ahead	Early cross	2 *	0 *	2 *
		Deep cross	9	8	17
	Behind	Early cross	2 *	14 *	16 *
		Deep cross	11	18	29
		SUM	24 *	40 *	64

*: $P < 0.05$

4. Discussions

4.1. Crossing and Reception points

Moderate correlation was observed between the abscissas and ordinates of crossing points (Fig. 2). This revealed that the closer the abscissas were to the goal line, the closer to the middle the crosses occurred. Deep crosses occurred in the penalty area. There were almost no crosses around the corner flag. These results are consistent with previous studies (Partridge and Franks, 1989a; 1989b).

Since crosses from around the corner flag must travel a long distance and present no possibility for goal shots, the goal keeper and other defenders can predict direction. However, crosses from the penalty area travel a short distance and have goal-shot potential. Therefore, it is difficult for defenders to predict direction or prepare for it. Furthermore, if crossers penetrate the goal line, the potential for a goal shot decreases, and it becomes difficult for defenders to identify the ball and mark. Because of this, cutbacks from the goal line to the negative

direction were designed. Spain's David Silva was a good example of this in the final match of EURO 2012. When crossing occurs from around the goal line, the goal keeper moves close to the near post to respond to a potential shot; and this makes it difficult for the goal keeper to clear high crosses to the far-post side. A few examples of these characteristics were seen in the WC 2010 Group League (Chile vs. Switzerland), including the goal made by Mark Gonzalez.

A total of 76.5% of reception points were in the PTA, which supported the results of the previous study (Partridge and Franks, 1989b). The PTA also overlaps with the high-scoring area (the fan-shaped area within 45 degrees at a distance of 16.5 m from the goal) indicated by Pollard (1997). Crossing to the PTA is an effective tactic when it is difficult to penetrate blocks created by defense players. This principle has not changed significantly in more than 20 years.

Crosses to the near-side concentrated on two points. The first was around the near post. Partridge and Franks (1989a) reported that quick crosses

should be kicked to the target area, which is behind the defenders (goal side) and inside the near post. The smaller the angle to the goal, the harder shooting becomes; and this lends credence to their assertion. However, five out of twelve crosses included in this study were received outside the near post. This may be due to measures taken by defenders to prioritize defense of the inside the near post. The other target of crosses was around the penalty arc. This is because of the backward crosses such as cutbacks. These account for the majority of crosses kicked outside PTA.

Relatively speaking, crosses to far-side were dispersed when compared to those to the near-side. Crossers are usually marked by defenders, which results in a limitation to the angle of crossing. If the angle is the same, crosses to the near-side can be received within a narrower area than crosses to the far-side. In addition, crosses to far-side remain in the air longer; however, the area in which receivers can move is larger. These characteristics may have influenced the dispersion of reception points.

Early cross reception points were concentrated in a vertically narrow area, which is significantly different from deep cross reception points. Specifically, fifteen out of 18 crosses (83%) were noted between the penalty spot and the goal area (5.5 m). Early crosses occur far from the goal and are consequently long, which make the crosses easier for the goal keeper to catch around the goal. It is also difficult to finish a strong shot far from the goal in receiving a cross delivered diagonally from behind. These are reasons why reception points were concentrated in an area located a certain distance from the goal.

As shown in **Fig. 4**, the abscissas of cross receivers and receiver approach angles based on the direction of cross showed moderate negative correlation. Receivers are away from the ball when they are on the near-side, and they move toward the ball when they are on the far-side. In other words, receivers move toward the middle of the pitch regardless of their position. In addition, as shown in **Fig. 5**, the abscissas of cross receivers and receiver approach distances revealed moderate positive correlation. This shows that the farther the receiver is into the far-side, the farther they move. Crosses to the far-side necessarily remain in the air longer, and the distance run is also long. These two factors suggested that even after crosses occur, it is effective for receivers to enter the PTA from the far-side, as evidenced by Cristiano Ronaldo' goal in the quarter-final match of

EURO 2012 (Portugal vs. Czech Republic).

4.2. Relative Reception Points

Partridge and Franks (1989a) argued that the offense should run behind the defense (goal side). The depth of the defense line, and gaps between the defense line and reception point revealed that more than half of crosses were received behind the defense (goal side). Meanwhile, eleven crosses (17%) were kicked to the front of the PTA. Many of these were crosses in the negative direction, including cutbacks, which is an effective use of the space generated when defenders return to the goal to respond to a crosser who has entered a deep position. This tactic takes advantage of crosses to the PTA. This was seen in Xabi Alonso's goal in the quarter-final match of EURO 2012 (Spain vs. France). Even without penetration to the goal line, which is the UEFA definition of a cutback, it is sufficient to press defenders to the depth of the goal area (5.5 m from the goal line). This is due to the fact that defenders tend to set back the defense line to the ball to protect their rear (goal side). Crosses far from the goal are very effective in taking advantage of such defense movement, and they are hard to block when aimed at the area around the penalty spot. This was seen in Diego Forlan's (Uruguay) volley that resulted in a goal in the match for third place of the World Cup 2010. An effective aspect of crosses that return to the negative direction after penetrating the side area was clarified.

In addition, the Abscissas of crossing points and lateral gaps among the defenders in early crosses revealed moderate correlation. When early crosses are delivered around the touch line, defenders against crosses spread sideways to the ball side to prevent penetration. Such sideways defense interferes with eliminating empty spots in the middle. Meanwhile, in the case of deep crosses, defenders tend to eliminate lateral gaps to prepare for crosses. These results suggested the effectiveness of randomly employing two tactics. The first is broadening of lateral gaps by penetrating the side, disturbing the defense, and increasing the lateral gap. The second is delivering early crosses.

The positional relation between middle-defenders and receivers in early crosses revealed a tendency for early crosses to be received at the far-side and goal side at a point deeper than middle-defenders, which

was significantly different from deep crosses. As mentioned above, for early crosses, defenders must prepare not only for crosses, but also for penetrations such as forward passes. Therefore, defenders tend to concentrate their attention and vision on the ball side. In such cases, it is difficult for defenders to respond to the far-side. If the team has an excellent crosser, it is effective to attempt early crosses to the far-side at a point deeper than defenders in the middle. **Fig. 3** shows that early crosses were concentrated in the space between the penalty spot and the goal area (5.5 m), and the goal width. This suggested the effectiveness of observing the relative relation between this absolute point and middle-defenders, and aiming to deliver early crosses.

4.3. Tactical Analysis Utilizing Location Information

Player location information is utilized to obtain fitness data such as running distance, speed, and sprint frequency (Mohr, M. et al., 2003), and tactical data such as play area, passing and shooting position (Kirkendall, D. T. et at., 2002). However, in invasion-type soccer games, tactical meaning varies in each game depending on the positional relation among defense, offense, space, and goal. Aggregation of player location information alone, however, is not sufficient for the evaluation of practical tactics involving the opponent. It is essential to define tactical analysis items as secondary data based on player location information, which is primary data, from the viewpoint of the soccer specialist (Suzuki and Nishijima, 2004). In this study, we defined analysis items for use as crossing evaluation indices based on offense and defense player location information. However, defining such practical secondary data is challenging. It is necessary to have an individual with both experience playing soccer and the ability to understand player intension to interpret location information and create indices. In regard to this, Nonaka and Konno (2003) suggested the SECI model based on tacit and explicit knowledge. SECI is a knowledge circulation model in which knowledge gained through experience and physical training (tacit knowledge) is converted into a form that can be transmitted to others (explicit knowledge), who then reconverted into tacit knowledge. In other words, investigators need to convert the tactics, rules and principles learned by players and coaches through experience into indices based on statistics and engineering. In order to obtain tactical indices of practical value from location information, cooperation among coaches and researchers, or individuals who have experience and knowledge is essential.

5. Conclusion

This study extracted the following characteristics of goal-scoring crosses in international soccer tournaments:
1. Crossers attempted to penetrate the penalty area and deliver crosses in areas close to the goal line. When defenders were organized, crossers penetrated by the goal line, and cutbacks were delivered to the penalty arc.
2. More than half of the crosses were delivered to the back of the defense line (goal side).
3. More than half of the crosses to the near-side were aimed at the post, and the rest were concentrated around the penalty arc. The former included crosses aimed outside the near post.
4. Receivers basically ran to the front of the goal. In particular, offensive players at the far-side in crossing made a long run laterally or diagonally to the PTA.
5. Most early crosses were kicked between the penalty spot and the goal area, and the far-side and goal side of the middle-defenders.
6. The closer early crosses were to the touch line, the larger the lateral gaps of defenders against crosses became.

6. Limitations in the Measurements

This study adopted manual measurement due to the research environment and data. For this reason, there are certain limitations involving sample size and measurement accuracy. Notation analysis has been automated along with improvement in image processing technology, contributing to the use of location information collection by tracking at international competitions and major league tournaments in various countries. Use of the massive amount of such highly accurate data would make it possible to conduct more detailed analyses, including analysis on factors to examine goal probability and success using crosses.

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Name:
Hiroshi Yamada

Affiliation:
Faculty of Sport Studies, Biwako Seikei Sport College

Address:
1204 Kitahira, Otsu-shi, Shiga 520-0503 Japan

Brief Biographical History:
2001- Doctoral Program in Physical Education, Health and Sport Sciences, University of Tsukuba
2006- Physical Coach, Tokushima Vortis, Japan
2012- Physical Coach, Gangwon FC, South Korea
2013- Lecturer, Biwako Seikei Sport College

Main Works:
• Yamada, H. and Nishijima, T. (2013) Validity of physical ability tests corresponding to the training phases of a soccer power development program. Japan J. Phys. Educ. Hlth. Sport Sci. 58: 663-675.(in Japanese)
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