Paper : Soccer

# New Goalkeeping Ability Index for Football Goalkeepers: Using a Regression Formula for Predicting the Probability of Goalkeeping Failure

**Yusuke Hirashima[*], Kensuke Suzuki[**], Masaaki Koido[***], Takeshi Asai[***] and Masao Nakayama[***]**

[*]Shizuoka University
836, Ohya, Suruga-ku, Shizuoka-Shi, Shizuoka-Ken 422-8529 Japan
hirashima.yusuke@shizuoka.ac.jp
[**]International Budo University
[***]University of Tsukuba

[Received April 14, 2023; Accepted October 24, 2023]

**Currently, the most commonly used goalkeeping ability metric for goalkeepers is Save percentage (SV%); however, SV% is not an effective evaluation index of goalkeeping ability because it does not account for goalkeeping-related difficulty. Recently, a regression equation was constructed to predict the probability of goalkeeping failure; with this equation, it has been possible to quantify goalkeeping-related difficulty. The purpose of the present study was to develop a new goalkeeping ability index for goalkeepers, which would take into account the degree of goalkeeping-related difficulty using a logistic regression model for predicting the probability of goalkeeping failure. To this end, we propose two new evaluation metrics: Saving Indicator (SVI) and Saving Score (SVS). Using SVI, SVS, and SV%, we evaluated the performance of goalkeepers who competed in the 2018 FIFA World Cup in Russia. Comparison of the three evaluation indexes revealed that both SVI and SVS considered the degree of goalkeeping-related difficulty but SV% did not. In future research, it will be necessary to evaluate an entire football tournament and season using SVI and SVS and to consider in detail the characteristics of each new goalkeeping evaluation index and how to specifically apply them.**

**Keywords:** soccer, goalkeeper, objective rating, logistic regression, game performance analysis

**[Football Science Vol. 20, 62-70, 2023]**

## 1. Introduction

Recently, many attempts have been made in Japan and abroad to quantitatively and objectively evaluate performances in the game of soccer (Oe et al., 2013). This is attributed to the fact that the scope of data that can be obtained has expanded as the technology has evolved over time and that the number of people who handle data and the scope of the use of data have also been increasing (Kato, 2016). For example, trainers in the team, who are responsible for improving the fitness and preventing injury, use GPS data for the measurements to check the intensity of the exercise, if the intended load was applied, and various other indices (Koido and Kagino, 2018). Additionally, as is said, “In the past, when considering the formation of the next season’s team or the acquisition of players, we could only make judgments based on actual play or impressions seen on video, but now (snip) it is possible to make judgments based on more concrete information” (Kato, 2016), there are an increasing number of situations in which such data are used by the strengthening department in charge of team organization, scouts, and others for evaluating players.

For the player evaluation, fans and supporters around the world evaluate players and teams from their own perspectives, using data published by their respective leagues, and publish their evaluations on SNS and other media. In Japan, DataStadium, Inc., which collects official J-League data as the J-League official data supplier, uses its own indices to evaluate players and teams in its “Football LAB” (https://www.football-lab.jp/). Looking at other parts of the world, 11 new indices as well as traditional data were provided for all matches by FIFA’s high performance team at the 2022 FIFA World Cup Qatar (FIFA, 2022). This is because until then, objective evaluation indices calculated from data were mostly used as content for fans, supporters, media, etc., and they were not necessarily used often to make decisions on team composition or player acquisition, but as the importance of objective evaluation increased, the development of new indices that are more useful in the field has progressed. For example, regarding the number of shots, O'Donoghue, P (2015) stated that "not all shots are the same, and some may be taken where there is little chance of scoring and a better tactical option might have been play a ball to a teammate in a better position to shoot." The index developed to resolve this issue is the expected goals (xG). The xG determines the quality of likelihood of a goal by calculating the likelihood of scoring from any position on the pitch during a particular phase of play (FIFA, 2022).

The same can be said for the save percentage (hereinafter referred to as SV%), which is the main index for evaluating the defensive ability of a goalkeeper (hereinafter referred to as GK). The SV% is expressed as the ratio of the number of saves to the number of shots on target, and it indicates the success rate in saving goals against shots on target (Nishiuchi, 2012). However, Hirashima et al. (2014) argued that the SV% does not "consider the difficulty of saving goals and is not a valid evaluation index in practice." They then used a logistic regression analysis to construct a regression equation that predicts the probability of failures in saving goals (hereinafter referred to as goal-saving-failure probability prediction regression equation), allowing them to quantify the difficulty level of goal saving. This has made it possible to show numerically what percentage of goals allowed as a team or what number of goals allowed was the responsibility of the individual GK. Furthermore, they argued that it is possible to gage the level of contribution to the goals allowed by a GK in a single match or season by accumulating these data and that this can be utilized as a new GK-evaluation index, which is useful for player selection and acquisition.

The goal-saving-failure probability prediction regression equation is already being verified in terms of reliability and validity. Hirashima et al. (2018) found that the inter-rater reliability and external validity of the failure probability calculated using the regression equation are high and that the equation is generalizable and useful in predicting goal-saving-failure probability based on the goal-saving ability of world-class GKs. However, no efforts have yet been made to develop a new evaluation index using this regression equation or to actually conduct an evaluation. The purpose of this study, therefore, was to present a new GK-evaluation index that takes into account the difficulty of goal saving for each shot by using the goal-saving-failure probability prediction regression equation and to compare the evaluation results of GKs using the new evaluation index and conventional evaluation index SV%.

## 2. Method

### 2.1. Subject

The matches covered were all 64 matches of the 2018 FIFA World Cup Russia (hereinafter referred to as 2018 WC). Only the first and second halves were included, excluding extra time and penalty shootouts. For each match, two GKs appeared from the two teams; the total number of GKs was 128. There was a match in which a GK was substituted, but for the purposes of this study, they were treated as the same person throughout the match.

### 2.2. Method of Measurement

The recorded satellite broadcast matches were replayed to conduct the measurements. In accordance with the measurement methods of Hirashima et al. (2018) and Suzuki et al. (2019), video images were played and paused for each shot on target, and the performance was measured. To minimize errors in measuring game performance from video, stadium miniatures used in the notational analysis (Hughes, 2003), a method that has been widely used in game analysis, were applied. With reference to a study by Grehaigne et al. (1997), 1-m$^2$ grids were drawn on the stadium miniatures so that the measurement accuracy could be ensured when distributing the location information of the players.

### 2.3. Measurement Items

As in the study by Hirashima et al. (2018), measurement items were the 10 factors incorporated into the goal-saving-failure probability prediction regression equation by Hirashima et al. (2014) as the main factors affecting the outcome of the goal saving; that is, shot duration, existence of defenders (hereinafter referred to as DFs) in front of the shooter, existence of DFs on the side or behind the shooter, shooting body part, shot type, horizontal shot trajectory, shot height, changes in trajectory caused by other players, shot-position angle, and shot-course distance were incorporated into the goal-saving-failure probability prediction regression equation as the main factors affecting the goal-saving result, and the success or failure of goal saving was measured for 11 items. These measurement items are described below, citing Hirashima et al. (2018).

#### 2.3.1. Shot duration

The duration from the time the shooter took the shot to the time the ball reached the goal was measured. For the shots that were scored without the GK touching the ball, the time from when the shooter took the shot until the ball completely crossed the line was measured from the number of frames in the video. For the cases where the GK stopped the shot and where the GK touched the ball but the goal was scored, the time from when the shooter took the shot until the GK touched the ball was first measured from the number of video frames. The position of the ball when the shooter took the shot and the position of the ball when the GK stopped the shot were then recorded, and the distance between the two points was calculated using the Pythagorean theorem. The average velocity of the ball was then calculated using the time and distance. Additionally, the distance between the position of the ball when the shooter took the shot to the center of the goal was calculated using the Pythagorean method. The time taken for the shot ball to reach the goal when the GK did not touch the ball was calculated based on the calculated average velocity of the ball and the distance between the position of the ball when the shooter took the shot to the center of the goal. The measurement unit of the time was 0.01 s.

#### 2.3.2. Existence of DFs in front of the shooter and 2.3.3. Existence of DFs on the side or behind the shooter

The defensive situation against the shooter was measured by the status of the defensive team players within 5 m of the shooter. As for the existence of DFs in front of the shooter, this is the presence or absence of DFs within a triangle formed by line segments connecting the ball to both goal posts and within 5 m from the shooter. With regard to the existence of DFs on the side or behind the shooter, this is the presence or absence of DFs outside the triangle formed by line segments connecting the ball to both goal posts but within 5 m from the shooter.

#### 2.3.4. Shooting body part

The body part from where the shot was made was determined. The shooting body parts were classified into (a) foot and (b) head.

#### 2.3.5. Shot type

The categories of shot type are as follows: (a) grounder: a shot that bounced at least twice after the shooter takes the shot and before the ball crossed the goal line or hit the goal post or goalkeeper, or alternatively, a shot that never exceeded knee height; (b) loop: a shot past the GK on parabolic trajectory; and (c) liner: any shot other than the grounder or the loop.

#### 2.3.6. Horizontal shot trajectory

Determination was made as to which lateral direction the shot was kicked with respect to the line segment connecting the position from which the shooter took the shot and the position of the GK at that time. The categories for horizontal shot trajectory are as follows: (a) near: a shot kicked in a direction close to the shooter as seen from the GK's position and (b) far: a shot kicked far away from the shooter as seen from the GK's position.

#### 2.3.7. Shot height

The height of the goal was divided into three equal ranges and classified in the order of (a) low, (b) medium, and (c) high, beginning with the lowest range.

#### 2.3.8. Change in trajectory caused by other players

The change in the trajectory of the shot by other players from the time the shooter takes the shot until the ball reaches the goal or the GK.

#### 2.3.9. Shot-position angle

The angle formed by connecting with straight lines the position of the ball when shot, the goal post near the position of the ball when shot, and the point where a straight line is drawn perpendicular to the goal line from the position of the ball when shot and intersects it was calculated using the Pythagorean theorem. If the ball was between the lines extended from both goal posts when the shot was taken, the shot-position angle was set to 90°. The distance from the center of the goal to the goal post was assumed to be 3.7 m. The measurement unit of the angle was 1°.

#### 2.3.10. Shot-course distance

The distance from the center of the goal to the center of the ball when the shot ball completely crossed the goal line was calculated. For shots that were scored without the GK touching the ball, the position of the center of the ball as it completely crossed the line was calculated using a goal miniature and the distance from the center of the goal was calculated using the Pythagorean theorem. A grid of 0.1 $m^2$ was drawn on the goal miniature. For cases where the GK stopped the shot or touched the shot, the position that the ball would be expected to pass through when crossing the goal line if the GK did not touch the ball was recorded and the distance from the center of the goal was calculated using the Pythagorean theorem. The measurement unit was 0.1 m.

#### 2.3.11. Success or failure of goal saving

For the success or failure of goal saving, success was awarded when the GK caught or deflected the shot ball to prevent it from going into the goal and failure was awarded when the goal was scored.

### 2.4. Calculation of the Goal-saving-failure Probability

The goal-saving-failure probability was calculated by substituting the in-frame shot situation measured by the game performance analysis into the goal-saving-failure probability prediction regression equation. To evaluate players, it is necessary to use the goal-saving-failure probability rate per shot as collected for each GK. For this reason, the goal-saving-failure probability prediction regression equation used in this study is expressed by adding the shot number, $i$, for each shot to the equation constructed by Hirashima et al. (2014), as follows:

$$Pi=1/(1+\exp(-(-2.245-0.5204_{x1i}-1.215_{x2i}-0.570_{x3i}+0.885_{x4i}+0.551_{x5i}+4.072_{x6i}+1.333_{x7i}+0.711_{x8i}+0.968_{x9i}+2.839_{x10i}+0.029_{x11i}+1.014_{x12i})))$$

Here, $x_1$: shot duration (s); $x_2$: DFs in front of the shooter, 1 for yes and 0 for no; $x_3$: DFs on the side or behind the shooter, 1 for yes and 0 for no; $x_4$: shooting body part, 1 for the head and 0 for the foot; $x_5$: shot type, 1 for the grounder and 0 for the others; $x_6$: shot type, 1 for the loop and 0 for the others; $x_7$: horizontal shot trajectory, 1 for far and 0 for near; $x_8$: shot height, 1 for medium and 0 for the others; $x_9$: shot height, 1 for high and 0 for the others; $x_{10}$: change in trajectory caused by other players, 1 for yes and 0 for no; $x_{11}$: shot-position angle (°), $x_{12}$: shot-course distance (m). The calculated values were rounded to the third decimal place.

### 2.5. Method of Evaluating Players

Three types of objective evaluation indices were used to evaluate the goal-saving ability of the GK.

The first was the conventional evaluation index SV%. This is calculated by dividing the number of saved shots, calculated by subtracting the number of goals (c) from the number of shots on target (n), by n.

$$SV\%=\frac{\text{n-c}}{\text{n}}\times 100$$

The second was the new evaluation index, saving indicator. First, an expected value of the projected goals allowed (hereinafter referred to as projected goals allowed) is calculated by summing up the goal-saving-failure probability (Pi) of each shot calculated using the goal-saving-failure probability prediction regression equation for each GK who receives the shots. Then, by dividing the actual goals allowed (c) by the projected goals allowed, it is possible to show the contribution of the GK to the goals allowed. This value is called saving indicator (abbreviated SVI) and is used as an evaluation index.

$$SVI(g)=\frac{\text{c}}{\sum_{i\in g}Pi}$$

The third was another new evaluation index, saving score. The projected goals allowed is calculated by summing up the goal-saving-failure probability (Pi) of each shot calculated using the goal-saving-failure probability prediction regression equation for each GK who receives the shots. By subtracting the projected goals allowed from the actual goals allowed (c), it is possible to show to what extent the goalkeeper increased or decreased the number of goals allowed. This value is called saving score (abbreviated SVS) and is used as an evaluation index.

$$SVS(g) = c - \sum_{i \in g} Pi$$

## 2.6. Statistical Analysis Method

### 2.6.1. Inter-rater reliability

Taking the studies by Hirashima et al. (2014) and Suzuki et al. (2019) as references, to investigate the inter-rater reliability for the measurement items, κ coefficients for category variables; that is, DFs in front of the shooter, DFs on the side or behind the shooter, shooting body part, shot type, horizontal shot trajectory, shot height, changes in caused by other players in the trajectory, success or failure of goal saving, and intraclass correlation coefficients for continuous variables (i.e., shot duration, shot-position angle, and shot-course distance) were calculated. A total of 44 shots on target that appeared in five matches were included in this analysis. The two raters had played and coached soccer and were engaged in scientific research on soccer. As the measurement was a repetitive process of pausing and replaying the video, each raters performed the measurement individually.

### 2.6.2. Relationship among three evaluation indices and each item

For SV%, SVI, SVS, average goal-saving-failure probability, number of shots, and projected goals allowed, the Kolmogorov–Smirnov test showed no normality for all items. Therefore, Kendall rank correlation coefficients (rk) were calculated to examine the correlation. The significance level was set at 5%.

# 3. Results

## 3.1. Intra-rater Reliability

As shown in **Table 1**, κ coefficients ranged from 0.77 to 1 for all items, with an average value being as high as 0.88. Additionally, the intraclass correlation coefficients ranged from 0.86 to 0.98 for all items, with the average being as high as 0.92.

**Table 1** Objectivity of measurement items

| Measurement items | κ coefficient |
|---|---|
| 2) DF in front of the shooter | 0. 77 |
| 3) DF on the side or behind the shooter | 0. 90 |
| 4) Shooting body part | 0. 92 |
| 5) Shot type | 0. 85 |
| 6) Horizontal shot trajectory | 0. 86 |
| 7) Shot height | 0. 87 |
| 8) Changes in trajectory caused by other players | 0. 85 |
| 11) Success or failure of goal saving | 1. 00 |
| **Measurement items** | **Intraclass correlation coefficient** |
| 1) Shot duration (seconds) | 0. 93 |
| 9) Shot-position angle (degrees) | 0. 98 |
| 10) Shot-course distance (m) | 0. 86 |

**Table 2** Basic characteristics of the subject (n = 128)

| | M | SD | MIN | MAX |
|---|---|---|---|---|
| Shots on target | 3. 8 | 2. 2 | 0. 0 | 11. 0 |
| Goals allowed | 1. 2 | 1. 1 | 0. 0 | 6. 0 |
| Number of saves | 2. 6 | 1. 9 | 0. 0 | 9. 0 |
| Average goal-saving-failure probability (%) | 29. 3 | 20. 0 | 0. 0 | 95. 3 |
| Projected goals allowed | 1. 1 | 0. 8 | 0. 0 | 4. 5 |

### 3.2. Basic Characteristics of the Subjects

As the basic characteristics of the targeted GKs, the number of shots on target, number of goals allowed, number of saves, average goal-saving-failure probability, and projected goals allowed per game were determined and the corresponding averages were calculated (see **Table 2**).

Additionally, the average evaluations of the GKs based on SV%, SVI, and SVS are shown in **Table 3**. Four of the 128 GKs could not be evaluated because they had no shots on target during the respective matches and were excluded from the subsequent sample.

**Table 3** Evaluation using three evaluation indices (n = 124)

| | M | SD | MIN | MAX |
|---|---|---|---|---|
| SV% | 65. 5 | 29. 7 | 0. 0 | 100. 0 |
| SVI | 1. 2 | 1. 3 | 0. 0 | 8. 5 |
| SVS | 0. 1 | 0. 8 | −2. 9 | 2. 2 |

### 3.3. Relationships among the Three Evaluation Indices and Each Item

#### 3.3.1. Relationships among evaluations by three evaluation indices

**Figure 1** shows the relationships between the evaluation using SV% and the one using SVI, the evaluation using SV% and the one using SVS, and evaluation using SVI and the one using SVS. Moderate negative correlations were found between SV% evaluation and SVI evaluation and between SV% evaluation and SVS evaluation ($rk = -0.62$ ・ $-0.48$, $p < 0.05$). A moderate correlation was also observed between the SVI evaluation and SVS evaluation ($rk = 0.69$, $p < 0.05$).

#### 3.3.2. Relationships between the Evaluations using the Three Evaluation Indices and Average Goal-saving-failure probability

**Figure 2** shows the relationship between the evaluations using SV%, SVI, or SVS and the average goal-saving-failure probability per shot. A moderate correlation was observed between the evaluation using SV% and the average goal-saving-failure probability per shot ($rk = -0.48$, $p < 0.05$).

#### 3.3.3. Correlations between Evaluations using the Three Evaluation Indices and Shots on Target and Projected Goals Allowed

**Figure 3** shows the relationship between the evaluations using SV%, SVI, or SVS and shots on target. No correlation was found between each of the two variables ($rk = 0.08$ ・ $-0.06$, $p > 0.05$).

**Figure 4** shows the relationship between the evaluations using SV%, SVI, or SVS and the projected goals allowed. A weak negative correlation was observed between the evaluation using SV% and the projected goals allowed ($rk = -0.25$, $p < 0.05$).

## 4. Discussions

Game performance analysis was used for data collection; however, it is necessary to consider objectivity in terms of intermeasurer reliability when measuring game performance through observation(Suzuki and Nishijima, 2002). The κ coefficient for two measurers was ≥0.77 for all items.

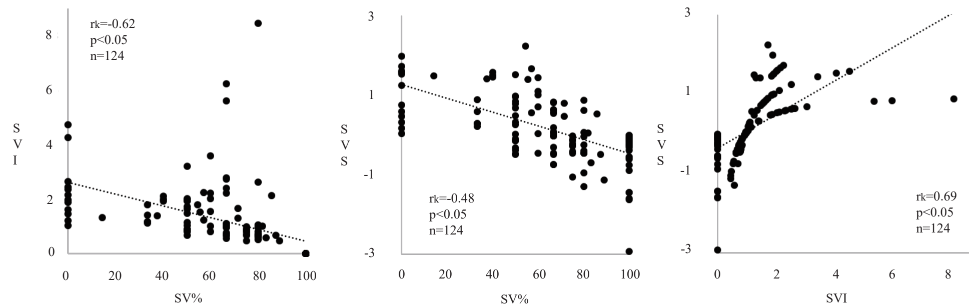


**Figure 1** Relationships between evaluations with SV% and SVI, with SV% and SVS, and with SVI and SVS

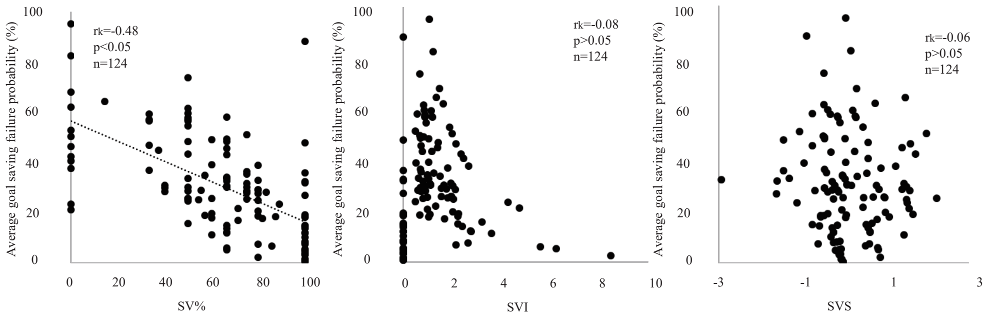


**Figure 2** Relationships between evaluations with SV%, SVI, or SVS and average goal-saving-failure probability

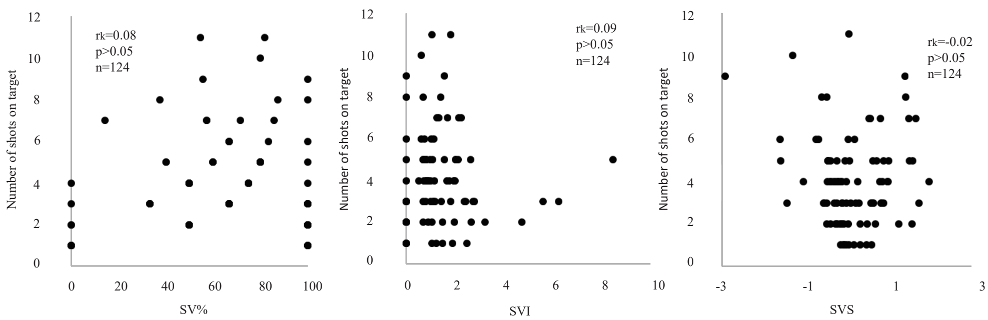


**Figure 3** Relationships between evaluations withy SV%, SVI, or SVS and shots on target

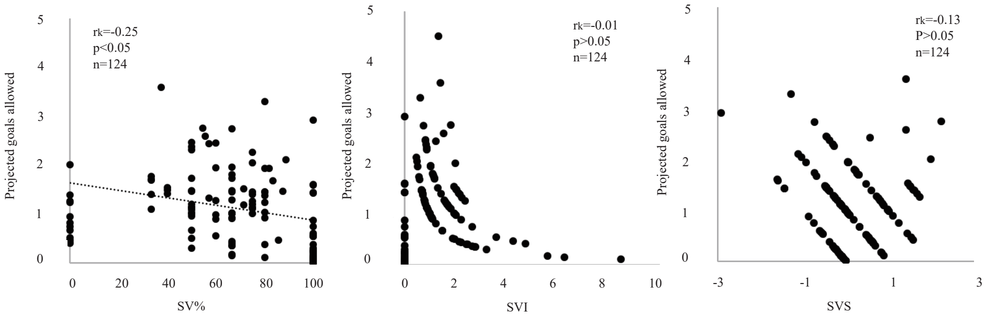


**Figure 4** Relationships between evaluations with SV%, SVI, or SVS and projected goals allowed

Moreover, it demonstrated a high value of ≥0.86 for all items (**Table 1**) in terms of the intraclass relative coefficient, which further confirmed that the analysis items used had a high degree of objectivity.

Validity is a concept concerning if a scale really measures what it is trying to measure (Kamahara et al., 1998), and a criterion-related validity, among others, is where performance indices for some aspect are evaluated against reliable standard criteria for that aspect (O'Donahue, 2015). SV% is a simple—involves dividing the number of goals saved by the number of shots on target—and currently the most important evaluation index for the goal-saving ability. Therefore, the SV% would be a standard criterion for validating if new indices are indeed assessing the goal-saving ability. In other words, examining the relationship between the evaluations using SV% and that using the new evaluation indices, SVI and SVS, is an indicator to prove the criterion-related validity of the new evaluation indices. The correlations between the evaluations with SV% and SVI, SV% and SVS, and SVI and SVS were moderate (**Figure 1**). Konno and Hori (1998) found no clear standard for correlation coefficients, but they did confirm the criterion-relevant validity of the scale through moderate correlations. It can be argued that, similar to SV%, SVI and SVS are also considered to be the indices that evaluate the goal-saving ability of goalkeepers.

Furthermore, the relationship between the evaluations using the three evaluation indices and the average goal-saving-failure probability per shot (**Figure 2**) showed a moderate negative correlations between the evaluations using SV% and the average goal-saving-failure probability per shot. Hirashima et al. (2014) stated that the conventional evaluation index, SV%, did not consider the difficulty of saving goals and was not an effective evaluation index in practice and that there is a need to develop a new GK-evaluation index by using the goal-saving-failure probability prediction regression equation. However, the usefulness of the assessment using SV% has not been verified in practice to date. The results of this study revealed that the problem with SV% was that it did not consider the difficulty of the goal saving, resulting in a higher rating for players who received easy shots. Moreover, as no significant correlations were found between the evaluation using SVI or SVS and the average goal-saving-failure probability, SVI and SVS are considered to be the evaluation indices that consider the difficulty of goal saving.

Additionally, in the relationships between the three evaluation indices and number of shots taken and between these indices and the projected goals allowed, a weak negative correlation between the evaluations using SV% and the projected goals allowed. As in the case of the average goal-saving-failure probability per shot, having a strong correlation is not good for the evaluation index because the GK cannot contribute to the increase or decrease in the number of shots taken and the projected number of goals allowed. As the players with lower average goal-saving-failure probability as well as lower projected goals allowed are likely to be rated higher with SV%, it is still not a useful index for properly evaluating players. SVI and SVS were not correlated with the number of shots taken or the projected goals allowed, suggesting that they are the evaluation indices not easily affected by the development of the match.

Thus, SVI and SVS developed in this study are considered as indices that can be used to evaluate the goal-saving ability of the GKs based on the goal-saving difficulty and the match situation. As SVI divides the goals allowed by the projected goals allowed, it is possible to compare players' goal-saving ability across categories, competitions, and number of matches with different levels of goal-saving difficulty, suggesting that it is an effective index for player selection and scouting. As for SVS, because it is calculated by subtracting the projected goals allowed from the actual goals allowed, it is expected to be affected by the categories and the number of matches. However, it can be used to evaluate how many goals allowed even when the number of goals allowed was zero, suggesting that it is a useful index when revealing the most productive GK in a single match or tournament.

As SV% does not consider the difficulty of stopping shots, the problem exists that players with a low average shot-stop-failure probability and players with low predicted goals were evaluated more accurately. However, a moderate correlation with SVI and SVS was observed, and it can be easily evaluated; therefore, it is considered to be effective as a simple evaluation index.

This study was limited to the evaluation of a single match, but in the future, it will be necessary to evaluate players over the course of a tournament or a season to study in detail the characteristics of each evaluation index and how they can be utilized.

Moreover, the goal-saving-failure probability prediction regression equation, which is at the core of this evaluation, is constructed by Hirashima et al. (2014) using data obtained from the 2010 WC. However, it is yet to be updated. Furthermore, improvements can be made, for example, considering what to do if a shot is made by other than the foot or head. Therefore, moving forward the goal-saving-failure probability prediction regression equation will need to be updated and improved.

## 5. Conclusions

Herein, two new goal-saving-ability evaluation indices for GKs were presented based on a goal-saving-failure probability prediction regression equation. The objectives of this study were to actually evaluate GKs by using the new evaluation indices and a conventional evaluation index, as well as to compare the evaluation results; the following conclusions were obtained.

The new indices, SVI and SVS, were found to be the goal-saving-ability evaluation indices that consider the goal-saving difficulty. However, as the conventional evaluation index, save percentage, does not consider the goal-saving difficulty as predicted, it became clear that it is a problematic index for properly evaluating players in the field.

**Acknowledgments**

This work was supported by JSPS KAKENHI Grant Number JP19K19941.

**References**

FIFA (2022). Enhanced Football Intelligence Explanation Document. https://www.fifatrainingcentre.com/media/native/world-cup-2022/Enhanced%20Football%20Intelligence%20EN.pdf. (accessed 2023-04-11).

Grehaigne, J. F., Bouthier, D., and David, B. (1997). Dynamic system analysis of opponent relationships in collective actions in soccer. J. Sports Sci., 15: 137-149.

Hirashima, Y., Nakayama, M., Naito, K., Asai, T. (2014). Quantification of the degree of difficulty in making a save for a soccer goalkeeper. Japan J. Phys. Educ. Hlth. Sport Sci., 59: 805-816. (in Japanese)

Hirashima, Y., Asai, T., Fukayama, K., Nakayama, M. (2018). Verification of a regression equation to predict the probability of a football goalkeeper's failure to stop shots at goal. Japan J. Phys. Educ. Hlth. Sport Sci., 63: 315-325. (in Japanese)

Hughes, M. (2003). Notational analysis. In Reilly, T. (ed.), Science and soccer (2nd ed.) (pp. 343-361). London: Routledge.

Kamahara, M., Miyashita, K., Onogi, H., Nakazawa, J. (1998). Psychology Manual Questionnaire Methods. Kyoto: Kitaohji Shobo. (in Japanese)

Kato, K. (2016). Data Analysis and Team Enhancement in Soccer. IEICE Commun. Mag., 10(1): 29-34. (in Japanese)

Koido, M., Kagino, H. (2018). We compare subjectivity with objective data and look at the players on that basis. The coaching clinic ,32(13): 25-29. (in Japanese)

Konno, H., Hori, H. (1998). Effects of justice beliefs on injustice judgement. Tsukuba Psychological Research, 20: 157-162. (in Japanese)

Nishiuchi, H., (2012). With Yasuhito Endo, teams win 117% of the time Data shows a new fascination with soccer. Tokyo: SB Creative. (in Japanese)

Oe, J., Ueda, T., Okihara, K., Usui, S. (2013). Objective rating of game performance in soccer. Japan J. Phys. Educ. Hlth. Sport Sci., 58: 731-736. (in Japanese)

O'Donoghue, P. (2015). An introduction to performance analysis of sport. London: Routledge.

Suzuki, K., Asai, T., Hirashima, Y., Matsutake, T., Nakayama, M. (2019). Analysis of attacking play for creating goal scoring opportunities in the professional football league: focusing on passing. Japan J. Phys. Educ. Hlth. Sport Sci., 64: 761-775. (in Japanese)

Suzuki, K., Nishijima, T. (2002). Causal structure of the attacking skill in soccer games. Japan J. Phys. Educ. Hlth. Sport Sci., 47: 547-567. (in Japanese)

**Name:**
Yusuke Hirashima

**Affiliation:**
Shizuoka University

**Address:**
836 Ohya, Suruga-ku, Shizuoka 422-8529 Japan

**Brief Biography:**

2012-2018 Doctoral Program in Coaching Science, University of Tsukuba

2018-2021 Junior Assistant Professor, University of Tsukuba

2022- Lecturer, Shizuoka University

**Main Publications:**

- Hirashima, Y., Nakayama, M., Naito, K., Asai, T. (2014). Quantification of the degree of difficulty in making a save for a soccer goalkeeper. Japan Journal of Physical Education, Health and Sport Sciences, 59(2), 805-816.
- Hirashima, Y., Asai, T., Fukayama, K., Nakayama, M. (2018). Verification of a regression equation to predict the probability of a football goalkeeper's failure to stop shots at goal. Japan Journal of Physical Education, Health and Sport Sciences, 63(1), 315-325.

**Membership in Learned Societies:**

- Japanese Society of Science and Football
- Japan Society of Physical Education, Health and Sport Sciences
- The Japan Society of Coaching Studies
- Japanese Society of Test and Measurement in Health and Physical Education