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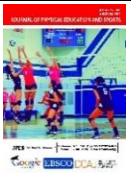

Development of Sensor Aids for Goalkeeping Violations Over the Goal Line on First Point Penalty Kicks on Futsal

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Abstract

Futsal game performance is strongly supported by the basic skills possessed by the players, futsal players must have good skills in some basic techniques. Goalkeeper is to minimize the opportunity of the opponent to score against his goal by using the right techniques and tactics, namely by catching the ball, blocking the ball, kicking the ball, and positioning the prime position. The results of observations that have been made by researchers, namely using observes and interviews with goalkeepers, referees and futsal coaches obtained conclusions stating that no tool can help the referee at the time of the first point penalty kick on futsal. The subjects of research are futsal goalkeepers academic futsal Cirebon and the referee asked Cirebon regency who already have a national referee license The result of this study is to produce a sensor tool product to detect the violation of the goalkeeper across the goal line on the first point penalty kick on futsal. result validation expert sensor, futsal and referee Dengan average scoreofeluruhan are "Good" which is 4.09% which has meaning in use. The test of small-scale product effectiveness with an overall average score is "Good" which is 79%. The large-scale product effectiveness test with an overall average score being "Good" was 71.5%. The conclusion of the research is to produce a product of developing sensor aids for the violation of the goalkeeper over the goal line on the first point penalty kick on futsal that can be used by the referee to help his performance.

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INTRODUCTION

Futsal is a variant of soccer, is a sport played around the world at amateur, semi-professional, and professional levels. The sport has a long history, dating back to the 1930s in South America, and is still known as *'futebol de sala* (translated from Portuguese) as *'FIFA's football hall* makes the standard of the sport of futsal and branded it the official version of '5-a-side' to create a structure that allows futsal to flourish throughout the world. FIFA then took over the holding of the futsal world championship since 1989 which was a triennial event. But with the time since 1996 turned into a quadrennial event.

Futsal is an indoor ball game played by two teams of five people each using ball manipulation techniques with the feet and limbs other than the hands by inserting the ball into the opponent's goal (Pratama, Arisandi, & Pradana, 2021) The sport of futsal has grown rapidly across the country in recent years. This rapid development is very beneficial because futsal has some positive aspects that will encourage the development of conventional football" (Scheunemann, 2011: 9). Futsal originated in Spain "Futebol Sala" which means football room.

Futsal is a "fast game with a short time with a narrow space" (Quiet, 2008: 68). Every futsal match is led by a referee who has full authority to uphold the rules of the game *(Laws Of The* Game).

The goalkeeper is a certain position that demands special characteristics and, therefore, he must dominate all aspects of the game, having a certain time of play (Marques, Travassos, & Sousa, 2019). In the game of futsal goalkeeper or goalkeeper has a very large role as the beginning of the attack and defending starts from the goalkeeper. In playing the ball, each player is allowed to use all limbs except hands and arms. Only goalkeepers are allowed to play the ball with their feet and hands (Susilawati & Primayanti, 2018). A futsal goalkeeper needs strength, speed and agility in carrying out his duties because the potential to experience collisions with the ball as well as with opponents is very high. Futsal goalkeepers can act as field players which is the most effective strategy for attacking in terms of increasing shots on the opponent's goal (Vicente-Vila & Lago-Peñas, 2016).

Goalkeepers play a part in this transition because goalkeepers can create chances when defending to attack with their throw into the empty front area as quickly as possible (Fauzi & Sidik, 2019) Futsal goalkeepers not only have the same skills as players but also must have some additional qualities, namely to master some special abilities for futsal. It often happens that the goalkeeper attacks or participates in his team's attack (Mănescu, 2013) In futsal, a goalkeeper as a field player should be able to create chances by shooting the ball into the opponent's goal at critical moments in futsal (Méndez, Gómez, Rúiz, & Travassos, 2019) In futsal, the goalkeeper does not only serve as the last wall but the function of the goalkeeper can also be as a feeder or even score goals. Kiper is an important part of the dynamics of the game when he participates beyond his old characteristics, that is, not only acts as a player who defends his goals, but can serve as another line player (Ganef, Pereira C. Reis, de Almeida, & Coppi Navarro, 2009).

Nature of this research the referee in question is a futsal referee". Wasit is someone who has full authority to uphold the rules of the game, from the moment of entry to exit of the field. A match will be able to take place when there is a field referee named referee (Gatot Darmawan, 2018). The referee is also assisted by the second referee in carrying out his appointed duties also to carry out duties on the opposite side of the field from the position of referee. The second referee helps the referee to supervise the match to keep it running by the rules of the player. In addition, off the field, the referee is assisted also by two assists, namely the third referee (third referee*)* and the timekeeper. Match devices commonly known as referees or more familiarly called referees are legitimate match

devices in leading the course of matches on the ground (Anra Wiono, 2020).

Many cases occur and interfere with the course of the match, one of which is due to dissatisfaction with the decision given by a referee. As the leader in a match, the referee is responsible for the course of the match and the final result of a match through the decisions he makes in the match, thus, the referee is required to give the right decision The referee as the holder of the decision in the match often gives birth to controversial decisions.

A referee who is on duty on the field is not only responsible to the referee's board and other judging teams, in this case, is the jury on duty. But he can also make decisions that can significantly affect thbehaviouror and reactions of players, coaches, spectators and officials watching the game (Rachmawati & Risma, 2021). A fast and stressful match is not enough to make room for the referee to think clearly and make accurate decisions. There are always teams that feel aggrieved by the referee's decision. Such events may arise because the referee who presides over the match, does not have a good understanding of the rules of the futsal game, thus affecting his attitude in making decisions. There is usually a hesitation to determine the attitude to be taken. Of course, to avoid these things a referee is required to have a high understanding of the rules of the futsal game so that it can have a good performance when leading the game.

The leadership of a referee is also very decisive because a little forgets to make a decision can result in the loss of one of the competing teams, if the referee can display a good performance when leading the match then the match will run smoothly and both teams can accept the final result of the match. Violations committed by the goalkeeper at the time of the first point penalty kick often go undetected by the referee due to limited vision of the referee, the first point penalty is committed if there is a violation inside the goalkeeper's area committed both by the player and by the goalkeeper himself.

In the first point penalty of course some rules must be known by the goalkeeper, one of which is that the goalkeeper must not cross the goal line before the opposing player kicks the ball, if the goalkeeper violates then the penalty kick can be repeated. There is often a confusion of referees in making decisions that consequently the match must be stopped because there are protests from teams who feel aggrieved by the decision of the referee.

The implementation of the first point penalty kick on futsal is that the goalkeeper must not move forward before the opposing player kicks the ball. The mistakes of the goalkeeper in the implementation of the first point penalty kick on futsal are: the initial position of the goalkeeper is above the goal line, should not move forward only allowed to move to the right and left, when the referee blows the whistle, the position of the goalkeeper is still above the goal line and when the opposing player is prepared to kick the ball then the goalkeeper is allowed to advance over the goal line.

In a match, observational differences often occur between referees, athletes, and coaches. One of them is in the difference of observation of errors on the execution of the first point penalty kick, which can lead to misunderstandings. This is due to several factors: (1) the concentration of the referee who is not focused, (2) the position of the coach who is outside the futsal field, (3) the position of the athlete who advances beyond the goal line. The difference in position is what causes differences in observation, judgment and misunderstanding. To overcome these problems, tools are needed that can help the observation of referees in decision making, equalize observations between referees, athletes, coaches and can provide evidence of a violation. We need a tool that solves this problem. In general, sensors are defined as tools capable of capturing physical or chemical phenomena and then converting them into electrical signals of either electric current or tense (Lia Kamelia, Yogi Sukmawiguna, 2017).

The sensor is basically like a switch that is useful to disconnect or connect the circuit in this case it blows the motor but automatically. In this

study, researchers used LDR resistor sensors. LDR or light dependent resistor is one type of resistor whose resistance value is affected by the light received by it (Supatmi, 2010). Light Dependent Resistor or abbreviated as LDR is a type of resistor whose resistance value or resistance value depends on the intensity of light it receives (Andi Julisman,Ira Devi Sara, 2017). The LDR sensor is a component that serves to detect changes in light intensity (Utama, Isa, & Rustandy, 2008). In general, LDR works based on the effect of the intensity of light coming on the sensor. The magnitude of light intensity will affect the magnitude of the resistance value in LDR (Bowo Eko Cahyono, Irna Dwi Utami, 2019). The goal in this development research is basically to create something new in the form of a sensor tool to detect the occurrence of a mistake or violation of the goalkeeper at the time of the first spot penalty kick. So this research aims to: (1) Make the design of motion sensors on the goal line in futsal games to facilitate the decision in determining errors or violations in the implementation of the first point penalty kick. And to provide evidence of a violation committed by the goalkeeper. (2) Knowing the effectiveness of the sensor tool on the front line is developed. (3) Knowing the acceptance of the goalkeeper's violation sensor aids at the time of penalty kicks in the sport of futsal This research produces development products in the form of sensors mounted on the right-left side outside the futsal field.

The sensor used in *laser* allows us to detect the presence of movement, used to detect whether a human or object has crossed the *laser,* which will cover the *Light Dependent Resistor (LDR)* so that it will be detected that someone is cutting the path of the *laser. Lasers are* small, cheap, low-power, easy to use and not easily damaged. *The LDR* is connected to an active alarm *speaker (Buzzer AC)* that will automatically sound if any object or movement crosses the *laser.* So the referee has evidence when there is one party who doubts the decision of the referee. To make it easier for the referee to control this tool, the On-Off system on the *laser* is controlled by using a remote control that is controlled by the *referee.* This development product is used in futsal matches to assist the referee in determining the goalie's foot error that crosses the goal line during the first point penalty kick.

METHOD

According to Sugiyono (2015), the research and development model is research used to produce a particular product and test the effectiveness of that product.

Researchers developed a sensor device on the wicket that is adapted to consideration of field conditions, time limitations, effort, and cost so as not to take on large subjects. The steps researchers use to create a motion sensor on the goal line are as follows:

1) Conduct preliminary research and gather information. Includes field observation and literature studies. 2) Develop the initial product shape (in the form of goal lines using sensors). 3) Evaluate the experts using two sensor experts, two futsal experts and two futsal referee experts. 4) Small group trials using questionnaires and consultations and evaluations are then analyzed. 5) Product revision first, product revision based on results from expert evaluations and small group trials. These revisions are used for improvements to the initial product made by the researcher. 6) Field test. 7) Final product revisions carried out based on field test results. The final result of modification of the sepak takraw field uses sensors.

The subjects in this development research are the goalkeeper of the Cirebon district futsal academy and the official futsal referee and ask who are already nationally licensed.

Table 1. The tools and materials used in this study are motion sensors using materials:

No	Tool Name	Sum
1	Adaptor	2
2	Laser beam box	1
3	Box LDR	1
4	Buzzer ac	1
5	Remote control	1
6	battery	2

Steps taken in the research on the development of modifications to the sepak field using sensors will be presented in the form of images, as follows:

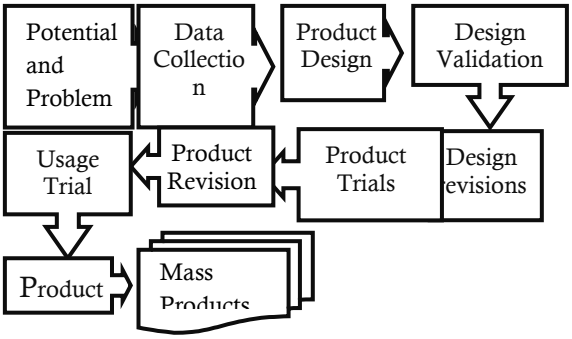

Figure 1. Steps for the Research *and Development Methods* (Sugiyono, 2015)

Small group trials

At this stage, the revised product and the results of the expert evaluation are then piloted to the futsal goalkeeper. In this small group trial, researchers tested on the goalkeeper of the Cirebon district futsal academy. Involving 10 men's alter, and 3 regional referees. All athletes try to do the starting position when there is a penalty kick on futsal by using a field that has been given censorship, which is led by three regional referees regularly. After the research activity is completed, respondents (athletes, and referees) fill out questionnaires that have been provided by researchers as a result of small group research.

Large group trials

The results of the analysis of small group trials as well as the first product revision then conducted a large group field test involving 20 goalkeepers and 5 national referees. All athletes try to do the starting position when there is a penalty kick on futsal using a field that has been given censorship, led by three regional referees regularly. After the research activity is completed, respondents (athletes, and referees) fill out questionnaires that have been provided by researchers as a result of large group research.

The data obtained is quantitative and qualitative. Quantitative data is obtained from what percentage of the product works and what percentage does not work. Qualitative data obtained from the results of the coercion given to respondents

RESULT AND DISCUSSIONS

Research development conducted by researchers through several stages. The research starts from initial product validation, product trials, namely small-scale trials and then use trials or large-scale trials until a mass product is produced where the product can be used for its benefits. This study involved 6 expert validators with their respective expertise, namely electronics experts totaling two validators and futsal material experts totaling two validators referee. A small-scale product trial involving 10 athletes and 3 refree. The large-scale trial involved 20 athletes and 5 refree.

Product validation is carried out using an instrument in the form of a questionnaire to find out how far this tool is said to be feasible to be tested. The questionnaire/ questionnaire used in the research process as product validation data and the effectiveness of the tool will be analyzed using a percentage formula that will produce data on whether the product is suitable for use or not. At the same time, data checking was carried out by using other data collection such as documentation and discussions on more sources in the same way, namely the observations of researchers and experts. The discussion that was conducted after the trial process on a small scale and large scale development of sensor aids for goalkeeping violations over the goal line based sensor that was used to provide comments and input was one of the techniques for checking the validity of the data by experts.

Descriptive notes are used to record and record all events carried out during the course of the study. Reflection is related to the proper provisions in the process of implementing the related usage trials in terms of knowing the effectiveness of the product development of sensor aids for goalkeeping

violations over the goal line . During the trial, recording and taking photos were carried out in an effort to meet the adequacy of references and documentation.

Before the developed product was piloted to the subject, the product made was evaluated first by two sensor experts, two futsal experts and two referee experts, related to face, construct and containnya. With expert qualifications: Sensor experts consisting of two people who have expertise in the field of electronics, namely: Khairul Anwar Ansari, S.Pd. T., M.Eng (Lecturer at SMK 1 Krangkeng majoring in Industrial Electronics Engineering) and Nursahidin, ST (Lecturer at SMK 1 Krangkeng) majoring in Industrial Electronics Engineering, two futsal experts consisting of Elan Maulana, S.Pd (Coach of Futsal Team Kab Cirebon) and M. Reza Indrawan, S.Pd (Coach of Cirebon City Futsal Team) and two referees already have a national referee license namely Hadi Winoko, S.Pd and Risa Hadi, M.Pd Variable evaluated by experts meliptui orosinalitas, tools and materials are used, security, comfort for players, tool functions, as well as the usefulness, and the usefulness of the tool. To collect data from experts used coercion. The results of evaluations from experts in the form of input and suggestions on products that have been made are used as a basic reference for product development.

Expert validation of the sensor is done in two stages. The first stage is the evaluation and assessment of the initial product before a small-scale trial. The second stage is the evaluation and validation of small-scale trial products to be tested on a large scale. The results of the sensor expert validation can be seen in table 1. The results of expert validation of sensors I and II showed that the quality of the product seen from the experts of sensor I and II stage I was declared "good" with an average score of 3.65. And the quality of stage II sensor tools seen from sensor experts I and II is declared "excellent" with an average of 4.80. Based on validation of stage I and stage II by two futsal experts on the motion sensor tool on the goal line in futsal games can be obtained data to be analyzed and used as a reference to make revisions.

Data was obtained through a questionnaire consisting of 20 questions regarding aspects of originality, usefulness, security, comfort, economy, and function of tools to be used properly at the time of the first point penalty kick In a futsal sports match.

Table 2. Accumulated Validation Results of Sensor Experts stage I and stage II

Stage		%	Mean	Classification	Meaning
I	II				
3.65	4.80	8.45	4.22	Excellent	Used

The validation results of futsal experts I and II showed that the quality of the product seen from futsal experts I and II stage I was declared "good" with an average score of 3.65. And the quality of the stage II sensor tool judging from the assessment of futsal experts I and II was declared "excellent" with an average of 4.47.

Table 3. Accumulated Validation Results of Futsal Experts stage I and stage II

Stage 1	Stage 2	Presentage	Average	Classification	Meaning
3.65	4.47	8.12	4.06	Good	Used

Table 4. Accumulated Validation Results Of Expert Referee Stage I dan stage II

Stage		Mean	%	Classification	Meaning
I	II				
3.55	4.47	8.02	4.01	Very good	Used

The results of expert validation of referees I and II showed that the quality of the product seen from the expert referee I and II stage I was declared "good" with an average score of 3.55. And the quality of the stage II sensor tool judging from the expert assessment of futsal referees I and II was declared "excellent" with an average of 4.47.

The table below is the final result of the validation of sensor experts, futsal soccer experts and referee experts against motion sensors on the goal line in the game of futsal.

Table 5. Accumulated Final Results Validation of Sensor Experts, Futsal and Referees

Experts						
Sensor	Futsal	Referee	%	Mean	classification	Meaning
4.22	4.06	4.01	12.29	4.09	Good	Used

The validation results of sensor experts I, II, futsal experts I, II and expert referees I, II showed that the quality of the product seen from sensor experts I, II, futsal experts I, II and expert referees I, II declared "good" with an average score of 4.09.

Table 6. Accumulated Quality of Products Results of Small Group Trials of Goalkeepers and Futsal Referees

Respond	Mean	Classification	Meaning
Keeper	97.44	Excellent	Used
Referee	97.73	Excellent	Used
Sum	97.58	Excellent	Used

The final result of sensor quality according to the small group trial as a whole got a percentage of 97.58% with the category "excellent" and meaning "used".

Tabel 7. Accumulated Quality of Products Results of Large Group Of Goalkeepers and Futsal Referees

Respond	Average	Classification	Meaning
Keeper	97.84	Excellent	Used
Referee	97.57	Excellent	Used
Sum	97.70	Excellent	Used

The final result of sensor tool quality according to the overall large group trial earned a percentage of 97.70% with the category "excellent" and meaning "used".

On small group trials on goalkeeping gets a 79% per cent with the category "good" and meaning in use. In large group trials on goalkeepers get a percentage of 71.5% with the category "good" and meaning in use.

This research produces a Futsal Goalkeeper Violation Detection Sensor On First Point Penalty Kicks that can help the referee's performance in making a decision related to the goalie's violation at the time of the first point penalty kick and can be evident when the goalkeeper commits a violation at the time of the first point penalty.

Technology is something that cannot be separated from daily life in modern times like today (Hartono, Sulaiman, & Rahayu, 2020). Based on several relevant research that has been done, one of them is the research by (Dianawati, Pramono, Woro, & Handayani, 2017) with the title " Development of Motion Sensor Devices on Double Event Service Lines in Sepaktakraw" from the research and development of this sensor device, it produces a motion sensor device on the double event servis line the sepak takraw game which is suitable for use in the double event sepa takraw match. Research by (Suwasono, 2017) with the title "Optimization of Futsal Goal Detection Accuracy With The Square Grid Method" This study develops a Goal Detection Accuracy Optimization system with the Square Grid method on a laser and photodiode and uses additional validation using a pixy camera and a referee that can work simultaneously and automatically in giving a decision whether a goal is valid or not. In system testing, the accuracy of ball detection on the futsal goal using the square grid method is 80%. Increased efficiency in using this system compared to the manual method by 30%. So, it can be said that technology and development of sensor aids for goalkeeping violations over the goal line are interconnected. Advance in sports science and technology have a positive impacton various sports fields such as training, refereeing and also competitions (Candra, Setyawati, & W, 2017).

Sensors are basically like switches that are useful for disconnecting or connecting the circuit in this case turning the motor on but automatically (Putro, 2017). In this study, the researchers used an LDR resistor sensor. LDR or light dependent resistor is one type of resistor whose resistance value is influenced by the light it receives (Supatmi, 2010).

	
BUZZER AC and LDR	Box Laser
	
Remote control	Adapter

Figure 2. components of Tool Used in Research

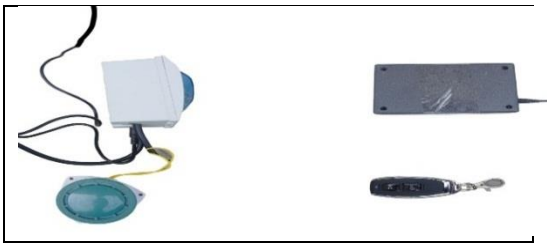

Figure 3. Set of tools

Figure 4. Goalie foul sensor tool How to use it

1) Make sure the appliance is in the area closest to the power source. 2) Attach the adapter to the laser beam box. 3) Place the laser lightbox on the right side outside the futsal field. 4) Attach the adapter to box LDR. 5) Place the laser lightbox on the left side outside the futsal field. 6) Connect the laser beam box adapter to an electric current. 7) Connect the LDR box adapter to the electric current and then press on the button in the box. 8) Connect the ac buzzer to the electric current. 9) Make sure the laser beam forms a straight line so that it can be captured by the LDR (distance according to the speed). 10) Press the *on* button on the remote. 11) The device goes off when there is the movement of an object blocking the laser beam into the LDR.

CONCLUSION

The research resulted in a development product in the form of a sensor device that was installed on the right and left sides of the futsal field. A tool that is produced to detect goalkeeper violations at the time of a penalty kick, as evidence or reinforcement for errors that have occurred. Result validation expert sensor, futsal and referee with average score of all are "Good" which is 4.09% which has meaning in use. The test of small-scale product effectiveness with an overall average score is "Good" which is 79%. The large-scale product effectiveness test with an overall average score being "Good" was 71.5%. research is to produce a product of developing sensor aids for goalkeeping violations over the goal line on the first point penalty kick on futsal worthy of use by the referee to aid his performance.

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