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# Biomechanical Analysis of Long Pass in U-19 Women Football Players

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**Abstract**

Kicking movement is process of moving position on leg. Biomechanical analysis explains kick performance which influenced by kinematics and kinetics factors. The research purpose analyzed biomechanical long pass movement. This research is both qualitative and quantitative. The research sample are 11 Indonesian woman football players who were taken by saturated sampling. Data in the form of long pass kick video with airborne ball test. Data analyzing used Kinovea software to determine the flexion angle of backswing kick leg, hip angle, and distance to target, then looking for the force, power, and energy in kick motion. The motion analysis shown that sample 3 produces closest distance to target as far as 0.65 m which done with flexion angle of backswing knee is 740 and hip angle of 640. The force exerted by sample 3 is 10.09 N, resulting in a ball speed of 22.42 m/s and a kinetic energy of 113.12 Joule, potential energy of 14.64 Joule and mechanical energy of 127.76 Joule. It can be concluded that accuracy of long pass kick are influenced by flexion angle of backswing kick knee, hip angle, power and force as well as producing energy in the form of kinetic, potential, and mechanical energy.

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## 1. Introduction

Football is seen as one of the oldest sports with the first set of formal rules established in 1848 in England, and today football is the most popular sport in the world (Worsey, et al., 2020: 1). Football is essentially the appearance of a movement consisting of elements of movement that are well coordinated, in this case it really depends on the ability of a player to take into account and foster their physical condition through the basic movements of the football player. The football is a type of game that has complex movements. This means that the movement consists of motion elements that are neatly coordinated, so that they can be played well. In order to play effectively and efficiently, perfect movement techniques are needed. Mastery of good movement skills can be obtained through research efforts in the field of sports biomechanics as a learning capital for motion and the supporting factors in the sport concerned. Sports biomechanics represents a science that provides quantitative and qualitative assessments of sports performance, especially the kinematics and kinetics of sports movements (Taborri, 2020: 2). Football is a game sport characterized by a variety of complex movements (walking, kicking, dribbling, jumping or falling) (Preljevi, et al., 2020: 197). Passing is part of the technical element with the ball and one of the first learning techniques in football (Sokoli, et al., 2020: 141). Long pass is one of the long-distance kicks in football. Long pass is done by kicking the ball with a bounce which aims to provide feedback to a friend. Based on observations made by researchers, Indonesian U19 women football players were not right on target in making long passes to their friends or did not bounce when kicked. Long passes are very necessary in defense where players can feed the hull to a friend who is in the opposing area or throw the ball away from the teams defensive area or feed the hull to an empty opponent area that can be reached by players on the same team. The increasing of long pass football is influenced by the quality of the muscles and the study of sports biomechanics. Sports biomechanics research often focuses on limb or the implementation of a movement and object velocity before and after impact to document performance effectiveness. Maximizing impulse transfer to change the objects momentum is the main objective. Activation of the muscles of the entire ankle joint can increase the transfer of momentum from the foot to the ball in a football kick (Gonzalez and Knudson, 2019: 21). Effective motion involves anatomical factors, physiological capacity, neuromuscular skills and psychological/cognitive abilities. The human body as a system is consisting of elements that are interrelated and connected to one another through the joints and existing muscle tissue. Biomechanical principles are used to describe the mechanical stresses on the body and the forces required to divides these stresses. Through the biomechanical analysis of the long pass movement, it can help coaches prepare training programs for football athletes. Exercises guided by biomechanical analysis aim to increase efficiency in long pass movements so that they are precise in carrying out long-distance passes, as well as so that movements that were previously difficult to do become easier and there is automation of motion in their implementation. This is because in sports, biomechanics can be used to evaluate the movements performed by athletes, so that athletes can improve their abilities and find out their weak points. Long pass kicks in football when preparing to kick the ball, if the right foot is going to kick in the preparation stage the right foot must be as far back or back swing as possible and vice versa when the front swing or swing forward is fast and strong, this is so the foot impact on the ball is large enough so that the ball will be as far forward as possible. This is in accordance with Newton IIIs law which states that if an object exerts an effect (force) on another object, then the other object also affects the first object. In a long pass kick, there are two interrelated movements, namely linear and rotational (angular) motion. Linear motion is the movement of an object as a whole from one place to another. In other words, it is the final result of the initial process of kicking the ball by bouncing it until the ball falls onto the target. At the execution time the ball can move either straight or curved.

When a football player kicks the ball, the foot movement will form a rotational or angular motion, which means that spinning occurs when an object moves in a circle around a fixed point. From the above statement it can be concluded that when doing long passing there is an angular velocity that will push the ball forward. When the angular velocity vector of a rotating object does not coincide with the flying speed vector of the object, latitude force will produce a perpendicular direction to the plane formed by the angular velocity vector and the linear velocity vector (Wang, 2019: 687). This speed affects the amount of force when kicking the ball which will result in maximum kick results. The front swing movement as fast as possible will result in a greater foot speed so that the impact of the foot is greater, which in the end the ball that is kicked will move forward resulting in a maximum distance from the kick result. The research purpose was analyzed the biomechanics of the long pass movement in Indonesian U19 women football players.

## 2. Methologogy

### *2.1. Time and Place of Research*

The research was conducted in Stadium University Sebelas Maret.

### *2.2. Research methods*

This research was used biomechanical analysis with qualitative and quantitative designs to explain the performance of the long pass which is influenced by kinematics and kinetics factors. The biomechanical analysis of the kick is divided into stages: backswing knee flexion angle, hip angle during movement, ball contact with the foot. The speed of the ball that is kicked depends on several factors: the speed of the foot before contact with the ball, the position of the body when kicking the ball, the length of the momentum and the angle of the kick (Aziz and Bylbyl, 2019: 19).

### *2.3. Sample*

The sample was 11 female football players who were taken by saturation sampling technique with the following criteria: (1) 19 years old, (2) female, (3) physically and mentally healthy, (4) good at mastering the long pass technique, and (5) willing to be research samples.

### *2.4. Data Collection and Research Instruments*

1. **Data collection**
   The data was collected by taking a video of a long pass kick which was demonstrated by a women football player.

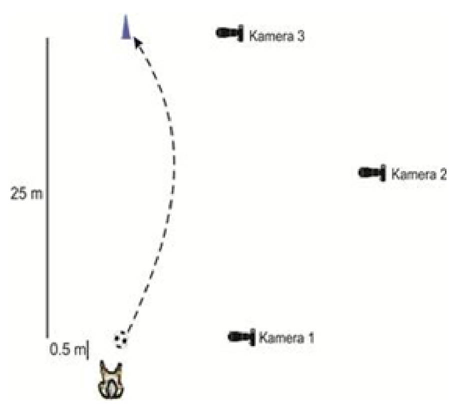



Figure 1: Video Capture

2. **Research Instruments**
   The research instruments were used darvis software, laptop, tripod, whistle, writing tools, battery, digital camera and instructions for implementing the long pass using the airborne ball pass test from Kryger, et al. (2018: 403). The cameras were used DSLR Conan EOS 1100D and DSLR Nikon D3200 DX 18-55 MM VR cameras. The analyzer facility in the Kinovea software application can make a motion that is run with slow motion. It aims to analyze the long pass movement.

3. **IoT in Data collection**
   Computational systems are used for the recognition and tracking of objects in image sequences. Computer analytics packages developed by the scientist for Intelligent search, automatically monitoring, and irregular identification. Kinovea is a free, open-source video player application that can extract video images through the concept of IoT.

*2.5. Long Pass Test Procedure*

The subject performs an airborne pass from the stationary ball starting position to a cone that is placed 25 m away. Subjects were instructed to pass the airborne ball ( 1 m above field) with instep to hit the target marked cone when the ball first bounced off the ground. Long passes are carried out 3 times which are used to determine the best long pass results. Long passing distances have been validated based on Opta Sportsdata Ltd. (London, UK) (Kryger, et al., 2018: 403).

*2.6. Analysis*

Motion analysis was carried out with Kinovea software to determine the flexion angle of the backswing kick leg, hip angle, and distance to the target. Then look for the magnitude of the touch force, power, kinetic energy, potential energy, and mechanical energy.Kinovea software is software that provides an object tracking system, either automatically or manually. Kinovea can be used to analyze variations in motion in two or three dimensions, observing the motion made by a video where the motion can be slowed down so that the results can be observed. Kinovea software used to convert any video into a series of images frame by frame (Haq, Arif, and Nawaz, 2020: 830). The main advantage of Kinovea is ease to use and analysis without the physical sensors and can be used in motion measurements. The following is the equation for force, power, kinetic energy, potential energy, and mechanical energy: Equation of touch force (1)

$$\mathrm{F} = \frac{\Delta \mathrm{p}}{\Delta \mathrm{t}}$$

Where:
$F$ = Style ($N$)
$\Delta$p = Change in momentum (Ns) $\Delta$t = Change in time (m/s2)
(Dinu, et al., 2020 : 3 )

The power equation (2)

$$\mathrm{P} = \mathrm{F} \cdot \mathrm{v}$$

Where:
P = Power (Watt)
$F$ = Style (N)
v = Speed(m/s)

The kinetic energy equation (3)

$$\mathrm{EK} = \frac{1}{2}\mathrm{mv}^2$$

Where:
EK = kinetic energy (Joule)
m = Mass of ball (0.45 kg)
v = Speed(m/s)

Potential energy equation (4)

$$\mathrm{EP} = \mathrm{m.g.h}$$

Where:
EP = Potential energy (Joule)
m = Mass of ball (0.45 kg)
g = *Gravity*(9.8 m/s2)
h = Height of the ball (m)
Mechanical energy equation (5)

$$\mathrm{EM} = \mathrm{EP} + \mathrm{EK}$$

Where:
EM = mechanical energy
EP = Potential energy

## 3. Findings

### *3.1. Data Description*

The data description describes the biomechanical analysis on a football long pass with a distance of 25 meters which was carried out by 11 samples. This data is a preliminary description, which will then provide motion analysis using the Kinovea software in the next results. The measurement results on the football long pass movement are shown in the table below.

1. **Kick Angle** Table 1 is shown the difference in the kick angle of each sample which results in the accuracy of the long pass target.

2. **Touch force and power**
   The amount of touch force generated by each sample is influenced by the amount of power. Great power will produce a large force and will affect the distance of the ball to the target, close to the target, right on target or more than the target.
   Table 2 shows the difference in touch force and power generated in each sample.

3. **Ball velocity and ball height**
   Table 3 shows the difference in ball velocity and ball height in each sample.

4. **Kinetic Energy, Potential Energy, and Mechanical Energy of Moving Ball**

Table 1: Angle of long pass movement of each sample

| Sample | Flexion angle of backswing kick leg | Hip Angle | Distance | The accuracy of the target point |
|---|---|---|---|---|
| 1 | 87 | 67 | 18.88 m | 6.12 m |
| 2 | 79 | 76 | 22.85 m | 2.15 m |
| 3 | 74 | 64 | 25.65 m | 0.65 m |
| 4 | 85 | 62 | 27.18 m | 2.18 m |
| 5 | 91 | 67 | 26.92 m | 1.92 m |
| 6 | 111 | 97 | 27.26 m | 2.26 m |
| 7 | 106 | 83 | 22.44 m | 2.56 m |
| 8 | 88 | 92 | 21.57 m | 3.43 m |
| 9 | 97 | 79 | 22.48 m | 2.52 m |
| 10 | 92 | 80 | 22.49 m | 2.51 m |
| 11 | 71 | 83 | 21.44 m | 3.56 m |

Table 2: Touch Force and Power

| Sample | Touch force | Power |
|---|---|---|
| 1 | 8.66 | 166.52 |
| 2 | 9.52 | 201.54 |
| 3 | 10.09 | 226.23 |
| 4 | 10.39 | 239.73 |
| 5 | 10.34 | 237.43 |
| 6 | 10.40 | 240.43 |
| 7 | 9.44 | 197.92 |
| 8 | 9.25 | 190.25 |
| 9 | 9.45 | 198.27 |
| 10 | 9.45 | 198.36 |
| 11 | 9.22 | 189.10 |

Table 3: Ball velocity and ball height

| Sample | Ball Speed | Ball Height |
|---|---|---|
| 1 | 19.24 | 2.55 |
| 2 | 21.16 | 3.17 |
| 3 | 22.42 | 3.32 |
| 4 | 23.08 | 3.28 |
| 5 | 22.97 | 4.42 |
| 6 | 23.11 | 3.62 |
| 7 | 20.97 | 2.59 |
| 8 | 20.56 | 2.57 |
| 9 | 20.99 | 2.78 |
| 10 | 21.00 | 3.52 |
| 11 | 20.50 | 2.62 |

Table 4: Kinetic Energy, Potential Energy, and Mechanical Energy

| Sample | Kinetic energy | Potential energy | Mechanical Energy |
|---|---|---|---|
| 1 | 83.26 | 11.25 | 94.51 |
| 2 | 100.77 | 13.98 | 114.75 |
| 3 | 113.12 | 14.64 | 127.76 |
| 4 | 119.86 | 14.46 | 134.33 |
| 5 | 118.72 | 19.49 | 138.21 |
| 6 | 120.22 | 15.96 | 136.18 |
| 7 | 98.96 | 11.42 | 110.38 |
| 8 | 95.12 | 11.33 | 106.46 |
| 9 | 99.14 | 12.26 | 111.40 |
| 10 | 99.18 | 15.52 | 114.70 |
| 11 | 94.55 | 11.55 | 106.10 |

Table 4 shows the differences in kinetic energy, potential energy, and mechanical energy generated in each sample.

*3.2. Analysis with Kinovea Software*

In football long pass kick, the accuracy of the long pass is influenced by the backswing and front-swing movements. Backswing is when preparing to kick the ball, if the right foot is going to kick in the preparation stage the right foot must be far back, while the front-swing is a forward swing motion. The amount of flexion angle of the kicking leg when backswing will have an effect on the impact of the foot on the ball large enough so that the ball will be as far forward as possible to the target or away from the target.

1. **Long pass movement of Sample 1**

(a)

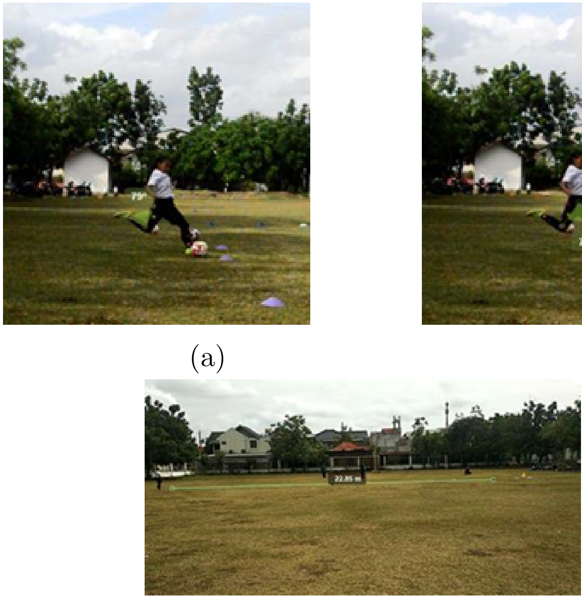
(b)

(c)

Figure 2: Long pass movement of Sample 1. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 2 shows the long pass movement of sample 1.In the picture, it was explained that in the preparation of the leg back, the knee is bent with a backswing flexion angle of 87° and a forward swing with a hip angle of 67° results in a long pass kick of 18.88 meters so that the accuracy of the kick results on the target is 6.12.

2. **Sample Long Pass Movement 2**




(a) (b)

(c)

Figure 3: Long pass movement of Sample 2. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 3 shows a football long pass motion of sample 2.In the picture, it is explained that in the preparation of the leg backswing, the knee is bent with a backswing flexion angle of 79° and a forward swing with a hip angle of 76° produces a long pass kick as far as 22.85 meters so that the accuracy of the kick results on the target is 2.15 meters.

3. **Sample Long PassMovement 3**


(a)


(b)

(c)

Figure 4: Long pass movement of Sample 3. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 4 shows the football long pass movement of sample 3.In the picture, it was explained that in the preparation of the leg back, the knee is bent with a backswing flexion angle of 74° and a forward swing with a hip angle of 64° results in a long pass kick as far as 25.65 meters so that the accuracy of the kick results on the target is 0.65 meters.

4. **Sample Long Pass Movement 4**

(a)


(b)

(c)

Figure 5: Long pass movement of Sample 4. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 5 shows the football long pass movement of sample 4.In the picture, it was explained that in the preparation of the back leg, the knee is bent with a backswing flexion angle of 85° and a forward swing with a hip angle of 62° results in a long pass kick of 27.18 meters so that the accuracy of the kick results on the target is 2.18 meters.

5. **Sample Long Pass Movement 5**


(a)

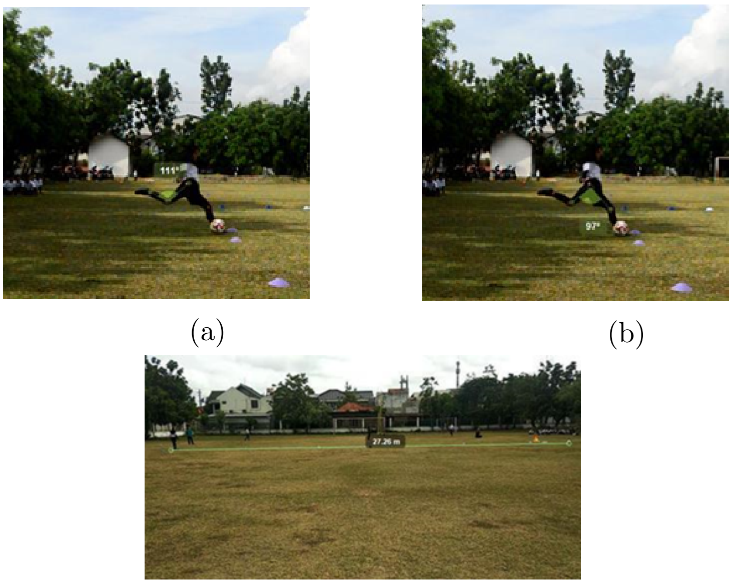

(b)


(c)

Figure 6: Long pass movement of Sample 5. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 6 shows the football long pass movement of sample 5.In the picture, it is explained that in the preparation of the leg back, the knee is bent with a backswing flexion angle of 91° and a forward swing with a hip angle of 67° produces a long pass kick as far as 26.92 meters so that the accuracy of the kick results on the target is 1.92 meters.

6. **Sample Long Pass Movement 6**



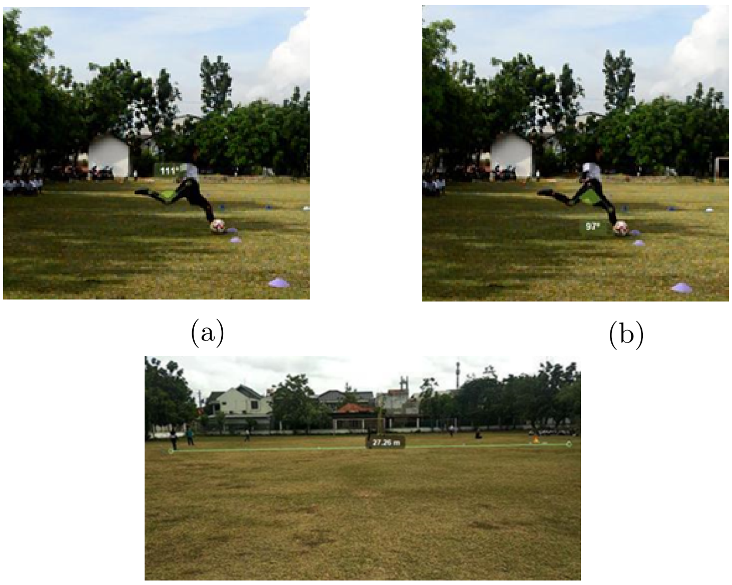

(a) (b)

(c)

Figure 7: Long pass movement of Sample 5. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 7 shows the football long pass movement of sample 6. In the figure, it is explained that in the preparation of the leg back, the knee is bent with a backswing flexion angle of 111° and a forward swing with a hip angle of 97° results in a long pass kick of 27.26 meters so that the accuracy of the kick results on the target is 2.26 meters.

6. **Sample Long Pass Movement 6**




(a) (b)

(c)

Figure 8: Long pass movement of Sample 6. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 8 shows the football long pass movement of sample 7. In the figure, it was explained that in the preparation of the leg backswing, the knee is bent with a backswing flexion angle of 106° and a forward swing with a hip angle of 83° results in a long pass kick of 22.44 meters so that the accuracy of the kick results on the target is 2.56

7. **Long Pass Movement of Sample 8**

(a)

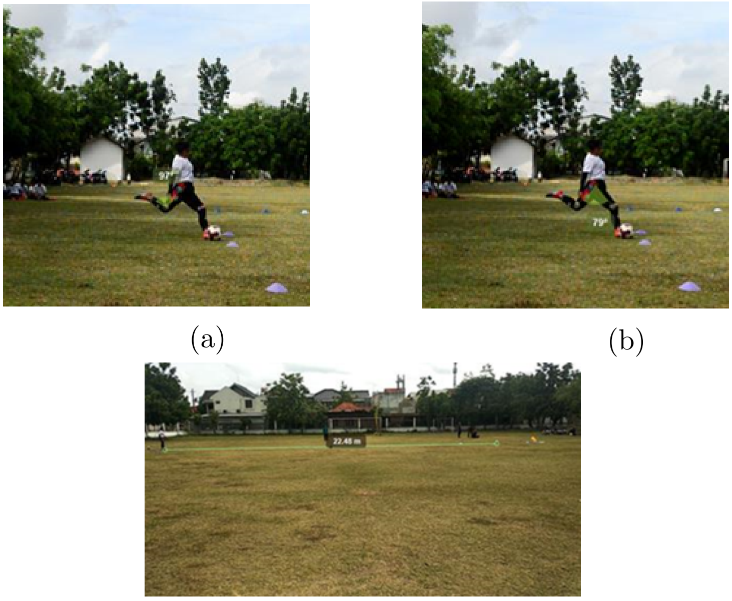

(b)


(c)

Figure 9: Long pass movement of Sample 8. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 9 shows the footballlong pass movement of sample 8. In the figure it is explained that in the preparation of the leg backwards, the knee is bent with a backswing flexion angle of 88and a forward swing with a hip angle of 92results in a long pass kick of 21.57 meters so that the accuracy of the kick results on the target is 6.12 meters.

8. **Sample Long Pass Movement 9**



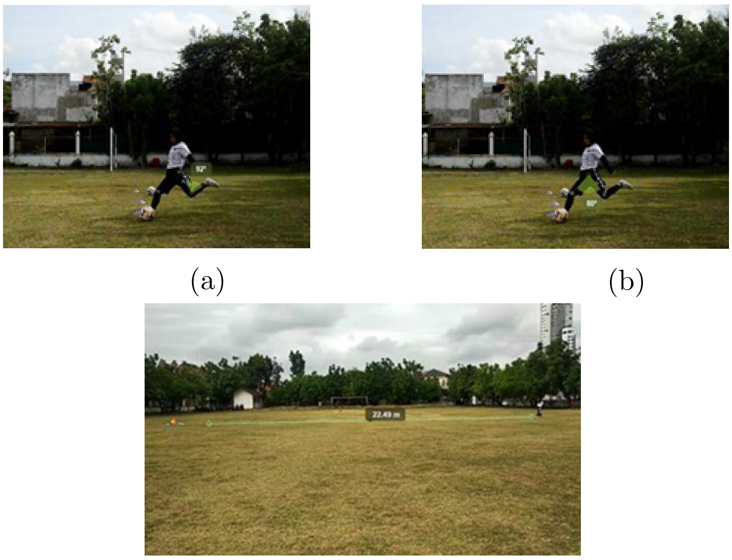
(a) (b)

(c)

Figure 10: Long pass movement of Sample 9. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 10 shows the football long pass movement of sample 9. In the figure, it is explained that in the preparation of the leg back, the knee is bent with a backswing flexion angle of 97and a forward swing with a hip angle of 79results in a long pass kick of 22.48 meters so that the accuracy of the kick results on the target is 2.52 meters.

9. **Sample Long Pass Movement 10**



(a) (b)

(c)

Figure 11: Long pass movement of Sample 10. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

Figure 11 shows the football long pass movement of sample 10. In the figure it is explained that in the preparation of the leg back, the knee is bent with a backswing flexion angle of 92and a forward swing with a hip angle of 80produces a long pass kick of 22.49 meters so that the accuracy of the results kick on target is 2.51 meters.

10. **Sample Long Pass Movement 11** Figure 12 shows the movement of football long pass of

(a)

(b)

(c)

Figure 12: Long pass movement of Sample 11. (a) Backswing flexion angle; (b) Hip angle; (c) The final position of the ball

sample 11. In the figure, it is explained that in the preparation of the back leg, the knee is bent with a backswing flexion angle of 71and a forward swing with a hip angle of 83results in a long pass kick as far as 21.44 meters so that the accuracy of the kick results on the target is 3.56 meters.

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## 4. Discussion

Passingcan be interpreted as the act of directing the ball to one of his teammates, to place the ball in favorable conditions against his opponent (Izzo, et al., 2020: 1996). Biomechanics studies on football long passes help improve performance and reduce the risk of injury to athletes. Increasing performance means increasing the effectiveness of motion. Effective motion involves anatomical factors. In anatomy, the main driving force of the kicking motion is the legs. At the time of the stance, the joint moves starting from the flexion of the knee and hip joints and the lifting of the right ankle leg. Meanwhile, when the left leg straightens, there is an extension of the hip, knee and ankle which gives repulsion. When kick the ball with right foot, the first joint pivot is in the hip joint. The knee is slightly flexed by a group of hamstring muscles that also takes the square and the straight extension ankle joint is contracted by the calf muscles. Previous research observed that after anticipated side-cutting, the time at the peak ground-reaction force was longer and the peak values were smaller than that of anticipated side-cutting. Flexion, valgus, and internal rotation in the knee joint are greater, and greater flexion and valgus are seen. Vastus lateralisand vastus medialisshow less activity, and lateral gastrocnemius shows higher activity after unanticipated side-cutting movements. With unanticipated cross-cutting, the peak ground-reaction force time was longer and the peak values were smaller than the anticipated cross-cutting, and the lateral gastrocnemius showed high activity. The difference in peak values of the mediolateral and the vertical forces is smaller in the cross-cutting motion than in side-cutting. Changes in hip joint flexion and adduction, knee joint flexion, and ankle joint inversion are greater during side-cutting (Kim, et al., 2014).

From the research results that have been stated, it can be seen that there are differences in the results of the long pass kick in each sample. Sample 3 produces a long pass kick that is almost precise when compared to other samples.The accuracy of long pass kick is the end result of stages starting from the stage of backswing, front-swing, and the impact that makes the ball bounce to the ball fall on target. Supported by the motion analysis, it shows that the results of the sample 3 long pass kick are the closest distance to the target, which is 0.65 m from the target. The distance that the ball falls is closest to the target, next is sample 5 which is 1.92 m from the target, sample 2 is 2.15 m from the target, sample 4 is 2.18 m from the target, sample 6 is 2.26 m from the target, sample 10 is 2.51 m from the target, sample 9 is 2.52 m from the target, sample 7 is 2.56 m from the target, sample 8 is 3.43 m from the target, sample 11 is 3.56 m from the target, and finally sample 1 is 6.12 m from the target which is the farthest distance of the ball falls from target.

The initial stage, namely backswing and front-swing, affects the results of kick performance. Performance in football kicks lies in two main factors, namely the result of the kick and the speed of the ball. These two factors are influenced by approach angle, magnitude of force, leg swing, hip and knee kinematics, foot contact with the ball (Cigoja, Vienneau, R. Nigg, & M. Nigg, 2018). The approach angle is the backswing flexion angle and the hip angle exerting a different force and will trigger the effect of the ball motion resulting from the kick. Physical activity in kicking the ball where the swing of footsare an important factor in producing optimal kicks. The hip angle is the angle of the swing. The greater the swing angle, the greater the force produced. The swing angle in sample 6 is the largest, which is 97when compared to other samples. With this angle sample 6 produces the greatest force which is equal to 10.40 N and produces the farthest long pass distance as far as 27.26 meters. However, the accuracy of sample 6 is less accurate because this angle is less effective for producing an accurate long pass or approaching a distance of 25 meters. The leg swing plays an important role in getting the right time to increase the force. The knee flexion angle when bent backwards or when backswing in sample 11 is the smallest, which is 71when compared to other samples. The knee support of the leg that is bent 26and remains bent up to 42throughout the length of the kick when contact the ball, this is used to stabilize the movement before contact with the ball which allows the muscles to generate high force (Less, et.al., 2010). The flexion angle of knee when bending the leg back also affects the magnitude of the force. A small angle of flexion results in a large force. However, in sample 11 the force generated is 9.22 N, this can occur because the power in sample 11 when taking a kick is not big enough so that it affects the size of the force. The power of sample 11 is 189.10 Joule/s.

The kicking movement is an action or a process of moving a place or position on the leg. Strong kicks are produced by muscle contraction, where in muscle cells there is a metabolism of chemical changes from chemicals converted into energy. Anything that moves at a certain speed has energy, so does a footballlong pass kick. A moving ball has energy that affects the direction of the target and the accuracy of the target. Energy is the ability to do work. A ball in motion has kinetic energy, potential energy, and mechanical energy. Kinetic energy is the energy caused by the motion of a ball that has mass. The faster the ball moves, the greater its kinetic energy. In addition, the kinetic energy of a ball is defined as the effort required to moves a ball with a certain mass from its initial state to reaching a certain speed. In order for the ball to be regularly accelerated until it moves at a certain rate, the ball is given a force in the direction of the balls motion as far as the distance traveled. The greater the force applied, the faster the ball speed, the greater the kinetic energy, and the resulting long distance. The results showed that sample 6 gave the greatest force of 10.40 N, resulting in ball velocity after collision with a rate of 23.11 m/s, a kinetic energy of 120.22 Joules, and a distance of 27.26 m. Potential energy is defined as energy stored because of the position to the reference point measured from the ground. The higher the position, the greater the potential energy. The results of this study indicate that sample 5 has a greater potential energy of 19.49 Joules when compared to other samples. This is influenced by the height of the ball when it is in the air and towards the target distance of 4.42 m. However, in a long pass kick, the height of the ball when it is in the air and the amount of potential energy has no effect on the distance. Mechanical energy is the energy in the ball that is kicked because of the speed at which it moves and its position from the ground. The mechanical energy in the long pass kick starts from the sample taking the kick which releases kinetic energy and the ball bounces upward so that it has potential energy and the ball falls to the target. The results showed sample 5 had a greater mechanical energy of 138.21 Joules when compared to other samples. This is influenced by the amount of kinetic energy and potential energy.

In a long pass kick to produce the right kick, it takes an ideal flexion angle and hip, ideal force and ideal power. Because the size of the angle does not produce the accuracy of the right long pass kick if it is not balanced with power. The ideal angle in this study is the angle in sample 3, namely the flexion angle of 74and the hip angle of 64.. In a long pass kick must also be balanced with power to generate force, because power and force that is too big or too small cause the ball to fall incorrectly on the target. The long pass kick also generates kinetic, potential, and mechanical energy. The greater the force, the greater the kinetic energy, but it does not confirm the amount of potential and mechanical energy because the potential energy is influenced by the height of the ball while in the air. The height of the ball in the air is not affected by the force applied. The results of this research support previous research that the kick start from the way the player approaches the ball to the end of the ball trajectory is the point that determines the success of the kick. This concern includes the overall technical characteristics such as foot support in the kick motion, foot impact with the ball and the characteristics of the ball slide and is related to the ball trajectory (Less, et al., 2010). In this study, researchers investigated the effect of knee motion that supports the leg during maximal instep kick in women football players. The results show that knee motion is affected by the speed of the kick leg. Researchers suggest that in women players, improved techniques to accelerate the hip joint of the upward kick and techniques to inhibit knee flexion during the forward swing will be important to produce higher leg velocity (Sakamoto, et al., 2020).

## 5. CONCLUSION

Based on the data analysis, it can be concluded that the accuracy of the football long pass kick results is influenced by the knee flexion angle of the backswing kick, hip angle, power and force and produces energy in the form of kinetic, potential, and mechanical energy. To produce a long pass that is on target, an ideal backswing knee flexion angle and hip angle are required. In this study, the ideal flexion angle is 74° and the ideal hip angle is 64°.

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