Biomechanical Analysis toward the Success Rate of Basketball Jump Shot Technique

Rumi Iqbal Doewes[1], Sapta Kunta Purnama[1], Islahuzzaman Nuryadin[1] and Manshuralhudlori[1]
[1] *Sebelas Maret University, Surakarta, Central Java, Indonesia*

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Abstract: The research objective was determined the biomechanical analysis toward the success rate of basketball jump shot technique. This is descriptive research used a case study method with planned test and movement analysis to collect the jump shot result. The research subject are 4 (four) female basketball player of Sebelas Maret University Basketball Unit. Data collection technique was used jump shot technique test with B.E.E.F method. Analysis data technique was used Kinovea software to analysis the movement during perform the jump shot. The research result was shown that from 4 subject that perform 40 jump shot was obtained 77,5% of success rate or 31 successful jump shot. From the successful jump shot from approximately 4 meters measurement of leg angle are about 106°-138°, elbow angle are between 58°-90°, the jump height are between 0,20-0,32 meters and throwing angle are about 46°-55°. The research result was shown that the best and effective jump shot viewed from biomechanical aspect on distance of 4 meters for players with height under 165cm measurement of leg angle are between 106°-119°, the jump height is approximately 0,24 meters, elbow angle approaching 90° will produce throwing angle between 50°-55° and will affect the maximum height and maximum ball velocity to produce maximum success rate of basketball jump shot. And for players with height above 165cm measurement of leg angle are between 120°-130°, the jump height is approximately 0,28 meters, elbow angle approaching 90° will produce throwing angle between 48°-52° and will affect the maximum height and maximum ball velocity to produce maximum success rate of basketball jump shot.

1 INTRODUCTION

In the modern era, sports have developed both in the field of science and technology. The better sports facilities make people fonder doing sports activities to maintain health and fitness. In addition to aiming for health and fitness, sports are also used as a race for achievement. Basketball is one of the popular sports in the community. Basketball game is known as a dynamic and attractive sport, because this game was required a combination of physical abilities and technical skills quality.

To achieve maximum achievement, it is necessary progressive and sustainable exercises. The exercises forms are including of physical, technical, tactical and mental. These four components constitute an inseparable unit. In playing basketball needs components related to health and skills. The components of physical fitness related to skills are agility, balance, coordination, speed, power and reaction. The components related to health are cardio-respiration endurance, body composition, flexibility, muscle strength, and muscle endurance

One of the techniques that can be used to score in basketball games is shooting. Shooting in basketball is an attempt to enter the ball into the opponent's basketball ring by throwing the ball to reach the number. Shooting is one of the factors that determine victory in basketball games.

Jump shot is the shot type that most often used to score. Jump shot is usually used to put the ball in basket. Taking a jump shot in a basketball game required complex movements including movements of the arms, body and legs. These movements were influenced by the player position from the basket, the player's reach, and the position of the enemy player. Therefore to make a perfect jump shot requires coordination from the lower part of the body, such as the legs, back, shoulders, elbows, arms, wrist to the fingers.

In teaching jump shot techniques, it needs to be considered carefully in the process of

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implementation. Trainers have an important role in the process of implementation. So far in practice in the field many athletes have not been correct in carrying out jump shot movements, especially for beginner athletes. This is due to several factors, one of which is the coach who still rarely justifies in the training process. The trainer only provides material by giving examples and the trainer does not pay attention to the biomechanical aspects in practicing the training.

Biomechanics is the study of the structure and function of biological systems by means of the methods of mechanics. When someone has understand the concept of biomechanical, they can make their body to move accurately, minimize technical issue, give any support for sport equipment development, and help minimize injury.

For determining success rate and a technique analysis of jump shot from preliminary stage to the follow through stage biomechanically in the basketball game, then need do research with title of "Biomechanical Analysis of the Success Rate of Jump Shot Technique on Basketball Games" in order the players and trainers can know the jump shot detail movement in terms of biomechanics and success rate.

2 RESEARCH METHODS

This research was conducted at the basketball court of the Sebelas Maret University Sports Hall. Jl. Ir. Sutami No. 36A, Surakarta. This research was conducted for one day with one meeting. This research held on June 12, 2017. The research subject are 4 (four) players of women's basketball team of Sebelas Maret University Basketball Unit who have the best shooting skills.

The research type was used descriptive with case study techniques. The test design and motion analysis were used to collect data. In this study, each research subject performs a jump shot test that is in accordance with the BEEF (Balance, Eyes, Elbow, Follow through) concept and analyze the movements.

The results of biomechanical analysis of jump shot techniques in the form of 5 indicators that can determine the success rate of jump shot including of body position angle, ball speed, throw angle, jump height, and maximum ball height when perform jump shot and success parameters in shooting techniques jump shot was measured by the number of balls that enter to the basket.

The data collection technique was used systematic observation. Jump shot test with the BEEF concept where each athlete shoots from a 90 degree angle to the basket, 10 times alternately on one side of a basket and 4 meters away (on the free throw line) because distance in a shot can affect the ball speed, this was done to examine the success of the jump shot technique measured by the number of balls entered into the basket and two-dimensional cinematography in the form of video recordings which will be analyzed using the analysis system in KINOVEA software, which will analyze 5 indicators that can determine the success rate of jump shot including of body position angle, ball speed, throw angle, jump height, and maximum ball height when jump shot.

Biomechanical analysis of jump shot technique was used KINOVEA Software:

a. Calibrate the distance between shooters and basketball ring. To calibrate the distance between the shooter and the basketball ring can use the line features. This feature will help measure the distance on the video according to the actual distance, in this case the distance between the shooter and the basketball ring.

b. Movement angle analysis. To analyze the movement angles were contained in the jump shot technique, the angle feature found in KINOVEA was used. This angle feature can show how many angles there are on the shoulder -arm-wrist and hip-knee-ankle during the preparation stage in the jump shot movement.

c. Throw angle analysis. At the execution stage of shot, to analyze how many the throwing angle was used the angle feature, the same as in the analyzing process of the movement angle.

d. Jump height analysis. To measure the jump height was used the line feature, which has been automatically calibrated the distance between the player and the basketball ring, the jump height can be identified immediately after drawing a line on the screen that connects the player's feet and the floor surface.

e. Ball direction and speed Analysis. To track the ball motion that can analyze the speed or distance of thrown ball used the track path feature that will follow the motion of the object that has been determined and will leave traces of the movement of the object, in this case the ball. And there will be information about the speed of ball motion.

f. Maximum ball height analysis. To analyze the maximum ball height used the line feature that has been calibrated automatically, then when the ball has reached its highest point, a line can be drawn that connects the ball to the floor surface.

3 RESULTS AND DISCUSSION

3.1 Research Results

To achieve the desired goal then data was collected. Jump shot data was done by recording the subjects who shot for 10 times with a minimum distance of 4 meters and from a 90° angle to the basketball ring with a camera capable of recording at 60fps (frames per second). The data then analyzed used KINOVEA software.

The results of the biomechanical analysis of the jump shot technique in the form of 5 indicators that can determine the success rate in jump shot, including of jump shot angles were measured by the number of balls that enter the basket. The research results were explained in following table.

3.1.1 Subject 1

Body position, ball speed, throw angle, jump height, and maximum ball height, and success parameters in performing techniques present in the following table

Table 1: Results Test of Subject 1

Shoot	Distance (meters)	Body Position		Jump high	Throw angle	Speed rate (m/s)	Max ball height (m)	Inf.
		Foot angle	Hand angle					
1	4.66	122°	73°	0.27	54°	4.71	4.05	Success
2	4.40	127°	72°	0.27	51°	7.68	3.96	Fail
3	4.93	124°	72°	0.29	51°	5.19	4.28	Fail
4	4.35	123°	72°	0.30	49°	4.57	3.98	Success
5	4.71	130°	70°	0.28	49°	5.06	4.06	Success
6	4.66	128°	74°	0.29	51°	4.75	3.96	Success
7	4.89	123°	68°	0.27	51°	5.09	4.06	Fail
8	4.58	123°	74°	0.28	51°	4.67	4.03	Fail
9	4.50	135°	73°	0.29	50°	4.83	4.05	Success
10	4.75	134°	71°	0.29	51°	5.10	3.96	Success

3.1.2 Subject 2

Table 2: Results Test of Subject 2

Shoot	Distance (meters)	Body Position		Jump high	Throw angle	Speed rate (m/s)	Max ball height (m)	Inf.
		Foot angle	Hand angle					
1	4.27	116°	86°	0.25	55°	3.92	4.23	Success
2	4.39	115°	90°	0.28	54°	4.48	4.16	Success
3	4.37	117°	86°	0.30	54°	4.60	3.97	Success
4	4.33	119°	87°	0.29	54°	4.20	4.15	Success
5	4.27	112°	89°	0.27	55°	3.99	4.34	Success
6	4.28	113°	90°	0.28	54°	4.32	4.08	Success
7	4.33	118°	89°	0.27	53°	4.42	4.03	Success
8	4.30	114°	90°	0.27	55°	4.39	4.09	Success
9	4.30	108°	90°	0.32	54°	4.53	4.02	Success
10	4.27	114°	89°	0.30	55°	3.88	4.38	Success

3.1.3 Subject 3

Table 3: Results Test of Subject 3

Shoot	Distance (meters)	Body Position		Jump high	Throw angle	Speed rate (m/s)	Max ball height (m)	Inf.
		Foot angle	Hand angle					
1	4.37	114°	58°	0.2	51°	4.60	3.49	Success
2	4.61	114°	62°	0.23	51°	4.85	4.02	Success
3	4.68	111°	59°	0.24	50°	4.82	4.06	Success
4	4.43	108°	70°	0.26	50°	4.52	4.08	Success
5	4.74	110°	65°	0.29	52°	4.43	4.34	Fail
6	4.18	106°	59°	0.26	48°	4.92	3.69	Success
7	4.18	112°	62°	0.25	50°	4.49	3.89	Success
8	4.36	116°	67°	0.24	52°	4.64	3.93	Fail
9	4.41	104°	72°	0.25	51°	4.79	3.75	Success
10	4.24	110°	61°	0.27	52°	4.82	3.98	Fail

3.1.4 Subject 4

Table 4: Results Test of Subject 4

Shoot	Distance (meters)	Body Position		Jump high	Throw angle	Speed rate (m/s)	Max ball height (m)	Inf.
		Foot angle	Hand angle					
1	4.66	122°	73°	0.27	54°	4.71	4.05	Success
2	4.40	127°	72°	0.27	51°	7.68	3.96	Fail
3	4.93	124°	72°	0.29	51°	5.19	4.28	Fail
4	4.35	123°	72°	0.30	49°	4.57	3.98	Success
5	4.71	130°	70°	0.28	49°	5.06	4.06	Success
6	4.66	128°	74°	0.29	51°	4.75	3.96	Success
7	4.89	123°	68°	0.27	51°	5.09	4.06	Fail
8	4.58	123°	74°	0.28	51°	4.67	4.03	Fail
9	4.50	135°	73°	0.29	50°	4.83	4.05	Success
10	4.75	134°	71°	0.29	51°	5.10	3.96	Success

3.2 Discussion

Based on the data that has been presented in the data analysis results above, that of the 4 research subjects who jumped as many as 40 jump shot obtained a success rate of 77.5% or as many as 31 jump shots that entered the basketball ring.

3.2.1 Subject 1

In the first subject with 177cm height, 10 jump shot shots with 80% success rate at an average distance of 4.30 meters, with an average foot angle of 129.5°, average hand angle at preparation of 71.6°, the average jump height is 0.29 meters, the average throw angle is 50.13°, the average maximum ball height is 4.5 meters and the average speed is 4.88 m/s.

The first subject failed as much as 20% or two shots with a distance of 4.48 and 4.38 meters, foot angle 126 ° and 144 °, hand angle during preparation 61 ° and 63 °, jump height 0.27 and 0.29 meters, throw angle 46° and 50°, average ball speed 5.14 and 4.61 m/s and the maximum ball height is 3.98 and 4.22 meters.

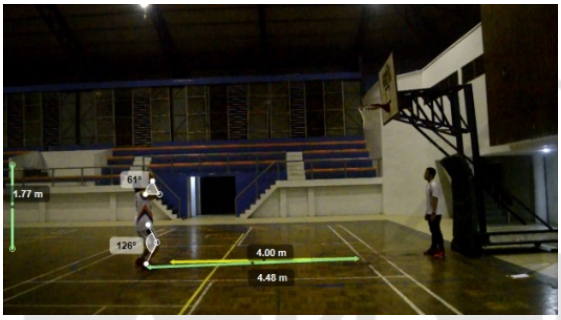

Figure 1. Preparation stage of Subject 1

3.2.2 Subject 2

In the second subject with a height of 160cm, performing 10 jump shot shots perfectly with a 100% success rate at an average distance of 4.31 meters, with an average foot angle of 114.6°, an average hand angle at preparation of 88.6°, average jump height of 0.28 meters, average throwing angle of 54.30°, average maximum ball height of 4.27 meters and average speed of 4.15 m/s.

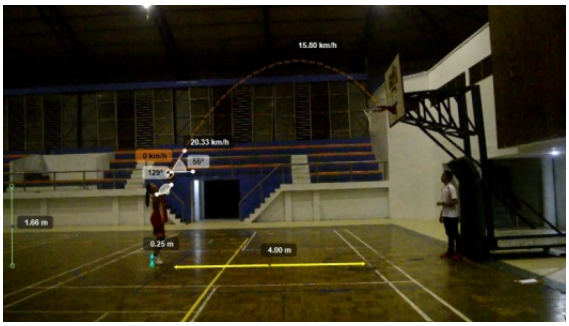

Figure 2. Implementation Stage of Subject 2

3.2.3 Subject 3

In the third subject with height of 156cm, doing 10 shots jump shot with a success rate of 70% at an average distance of 4.41 meters, with an average foot angle of 109.86°, average hand angle at preparation of 63.14°, the average hand angle when releasing the ball 143.86°, the average jump height of 0.24 meters, the average throw angle of 50.14°, the average maximum height of the ball is 4.71 meters and the average speed of 3.89 m/s.

The third subject failed 30% or three shots with shots distance of 4.74, 4.36 and 4.24 meters, foot angle of 110°, 116° and 110°, hand angle during preparation of 65°, 67°, and 61°, jump height of 0.29, 0.24 and 0.27 meters, throw angle of 52°, 52° and 52°, average ball speed of 4.43, 4.64 and 4.82 m/s and ball high maximum of 4.34, 3.39 and 3.98 meters.

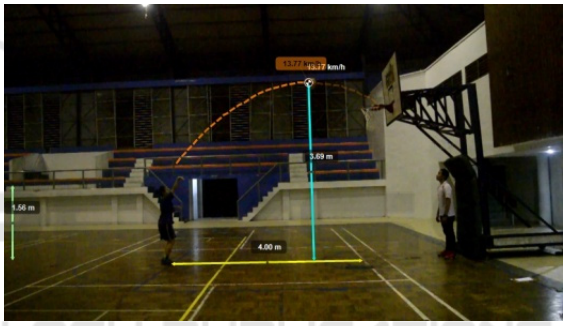

Figure 3. Follow through stage of Subject 3

3.2.4 Subject 4

In the fourth subject with 166cm height, 10 jump shot shots with 60% success rate at an average distance of 4.61 meters, with an average foot angle of 128.67°, average hand angle at preparation of 72.17°, the average hand angle when releasing the ball of 130.17°, the average jump height of 0.29 meters, the average throwing angle of 50.67°, the average maximum ball height of 4.84 meters and the average speed of 4.01 m/s.

The fourth subject failed 40% or four shots with shots distance of 4.4, 4.93, 4.89 and 4.58 meters, foot angle of 127°, 124°, 123°, and 123°, the angle of the hand angle at preparation of 72°, 72°, 68°, and 74°, high jumps of 0.27, 0.29, 0.27, and 0.28 meters, throw angle of 51°, 51°, 51°, and 51°, average of ball speed of 4.68, 5.19, 5.09, and 4.67 m/s and the maximum ball height of 3.96, 4.28, 4.06 and 4.03 meters.

4 CONCLUSIONS, IMPLICATIONS AND SUGGESTIONS

4.1 Conclusion

Based on the data analysis results, it can be concluded that the best and most effective jump shot in terms of biomechanics at a distance of 4 meters is the foot angle for players who are below 165cm between 106°-119° with jump height of 0.24 meters to get a more optimal upward push, effective elbow angles are close to 90° and the throwing angle is between 50°-55° to produce optimal ball shots with parabolic movements towards the basketball ring.

Players with height of 165cm or more at foot angle between 120°-130° because the range to the basket is closer than that which has a lower body, the jump height approximately 0.28 meters to get a more optimal jump before shooting, the elbows angle effective are close to 90 ° and the throw angle is between 48°-52° to produce ball shots at optimal speed with parabolic movements towards the basketball ring.

Table 5. The most effective jump shot angle

Height	Distance	Foot angle	Elbow angle	Jump high	Throw angle
< 165 cm	4 m	106°-119°	±90°	0.24 m	50°-55°
> 165 cm	4 m	120°-130°	±90°	0.28 m	48°-52°

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4.2 Implications

From the above conclusions, it can be implied that to get the maximum success rate in performing jump shoot technique, an optimal elbow angle is needed, the momentum boost from the optimal body created from the foot angle and the optimal jump angle and throw angle will affect the maximum height and ball speed and make the ball move with the parabolic movement towards the basketball ring and increase the success rate of the ball to enter the basketball ring.

4.3 Suggestion

Regarding the research results of on biomechanical analysis of jump shoot techniques on basketball, the researcher wants to give the following suggestions:

(1) This research was expected to be a reference for trainers about jump shot techniques in terms of biomechanics to create an exercise program that can increase the success rate of jump shot. (2) This study was expected to add knowledge about effective jump shot movements in terms of biomechanics for players. (3) The players are expected to develop jump shot movements and improve less effective movements to get the maximum success rate in jump shots.

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