

# Step Dynamics Analysis in 100 m Sprint Biomechanics Study in Elite And Junior Sprinters

Veeramani Chidambaram  
*Institute of Technical Education*  
 College Central, Singapore  
 Veeramanic@hotmail.com

Ria Lumintuarso  
*Faculty of Sport Science*  
 Universitas Negeri Yogyakarta  
 Yogyakarta, Indonesia  
[loemin@yahoo.com](mailto:loemin@yahoo.com)

**Abstract**— This study aimed to determine the frequency of the step of 100 meters sprint, the research method used is to analyze the video with dartfish. The results of this study indicate that the anthropometry profile greatly determines the sprint running speed of 100 meters.

**Keywords:** *sprint, biomechanics, Step Dynamics*

## I. INTRODUCTION

The research study on sport performances are developing every day. Biomechanics analysis is one of the methods often used by sport science to analyse athletes' performance through video or still picture. Using video as performance analysis is known as cinematography. The video camera technology had improved tremendously especially in the capacity of picture, speed of the screen per-second and also the ability to take video with very simple equipment versus complex equipment.

In high performance sport, the biomechanics analysis aids development of performance rapidly. These are done through breaking down of the recorded images which can be broken for individual measurable sport significantly. With such information performances could be achieved through better training methods.

Athletics or track and field as a sport (running, jumping and throwing) is a measurable individual sport that can be analysed accurately by using video technology.

Considered the blue ribbon event of athletics the 100m sprint requires the sprinter to demonstrate the ability to generate an effective acceleration, amplify a technique efficient maximal velocity and endure that magnified velocity in the presents of fatigue Ross et al. (2001). The key to sprinting velocity are determined by two main components namely step length and step frequency. The characteristic of the step taken by the athlete thus becomes vital in achieving a positive performance.

In this paper we will be examining the following athletes: Usain Bolt - 9.58 seconds (Jamaica), Yoshihide Kiryu-9.98 seconds (Japan), Lalu Muhammed Zohri-

10.18 seconds (Indonesia) and Cray Eric Shuwan-10.25 seconds (Philippines).

The above mentioned athletes were chosen for their varying representation in nation, age and coaching methods. Additionally they are high performance athletes in their specific category. By comparing their sprinting performance based on step frequency and step lengths we can see the maximal ability of Usain Bolt as the world record holder in 100m, Yoshihide Kiryu of Japan the Asian sprinter who could run under 10 seconds, Cray Eric Shuwan of Philippines who is the 100m SEA Games 2015 winner and Zohri of Indonesia, the champion of 100m under 20 World Championships 2018 in Finland. The aim is to establish the key aspects that will serve the potential prospect of Lalu Mohammad Zohri with regards to his capacity to perform in the senior level.

## II. METHOD

Video footage of the race was used. The video were then uploaded on the dartfish video analytic software to obtain the time and number of steps taken. During the video analysis every 10 steps taken, time was recorded. This was done thereafter for the every subsequence 10 steps until the finish.

Distance marking on the track was used to estimate to the closest to gauge the distance as the athlete past them. Steps taken to reach the distance was then estimated to the nearest possible to establish the number. From the results the step frequency and step lengths were calculated used the excel worksheet.

## III. RESULT

4 sets of 10 steps were obtained from the video. The first set 10 steps of all the four sprinters were closely cluster together ranging from 3.97 to 4.12 steps per second. The subsequent 3 sets of 10 steps had a profile range different of 0.45 steps per second. Figure 1 display these result.

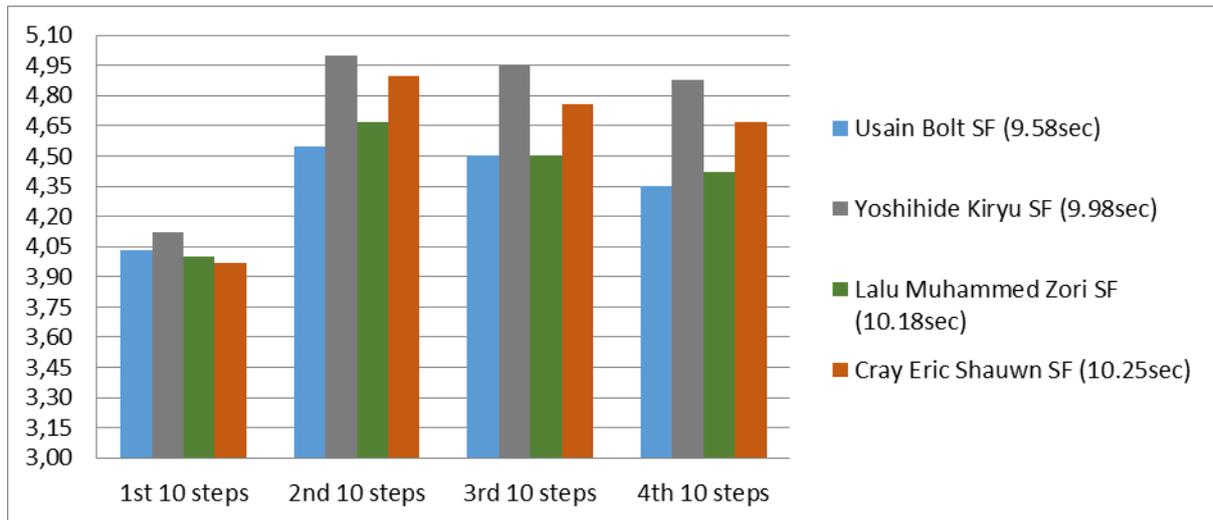


Figure 1: Step frequency analysis

From the Figure 1. It is shown that step frequency. Yoshihide Kiryu is the best in step frequency from the first 10 steps to 4<sup>th</sup> 10 step. The second best on step frequency is Cray Eric Shauwn and he ran 10.25 sec. Lalu Mohammad Zohri who is running 10.18 shows better step frequency than Usain Bolt in second, third and fourth 10 steps.

The data available for assessing the velocity, step frequency and step length were limited thus only Usain Bolt and Lalu Muhammed Zohri could be analysed.



Figure 2. Step Length Comparison Bolt and Zohri

From figure 2 it is clear shown that the step length of Bolt is clearly bigger than Zohri's step length. It was noticed that Bolt step length continued to increase from 20m to 100m at each of the 20m section. Zohri's step length increased in

the first 20m section then it stabilised from 40-60m zone before increasing through the last two 20m section. The biggest step length of Zohri is 2.71 meters and for Bolt is 2.85 meters.

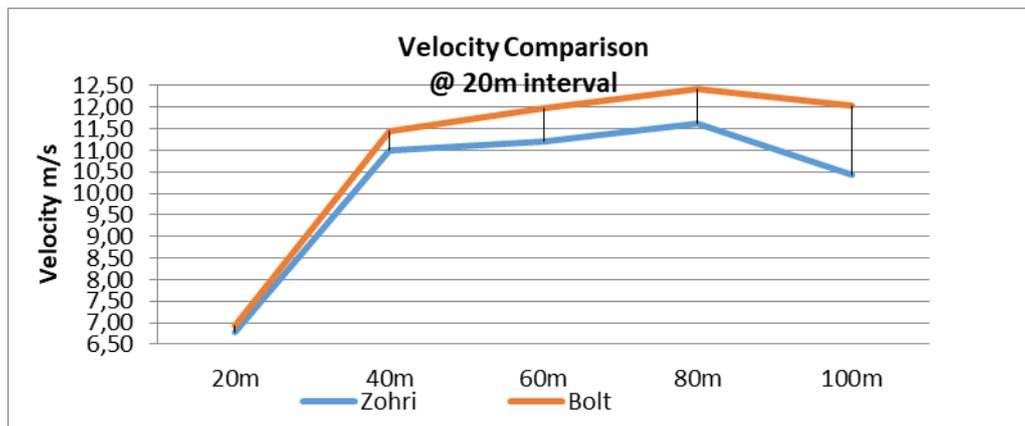


Figure 3. Velocity Comparison Bolt and Zohri

According to Figure 3, the speed between Bolt and Zohri is significantly different. The acceleration phase shows that Bolt and Zohri had similar duration. Bolt had a higher ability.

#### IV. DISCUSSION

##### A. Step Frequency

From the Figure 1, Lalu Mohammad Zohri who is running 10.18 shows better step frequency than Usain Bolt in second, third and fourth 10 steps sections. Nevertheless compared to Kiryu and Shauwn he is still slow. One of the aspect for Zohri is he may need to improve his step frequency. By having same steps length and better step frequency as Kiryu and Shauwn we presumed Zohri can run under 10 sec.

On the other hand it is difficult for Zohri to achieve perform closer to Bolt's performance. Bolt has lesser step frequency in comparison to Zohri but has superior step length due to his huge body size.

An important point that can be taken from this step frequency study is that Zohri has a step frequency level comparable to that of a world junior. Zohri not only has limitations (limitation factors) but there are still opportunities to be improved as well.

##### B. Step Length

From the above data's, Zohri still has inferior step length compared to Usain Bolt. This weakness makes the opportunity for Zohri as an element that can still be improved. The weakness in step length is the challenge for Zohri in the future to get the correct task in training that suits his main needs.

Weaknesses (limitation) in step length are usually caused by the lack of strength which is the foundation (sources) for increasing the speed strength needed to give a more optimal pushing effect on the foot support.

If Zohri can increase the step length capacity, with the same step frequency, its performance will increase significantly.

Problems that can arise as an effort to increase step length are:

- Step length increases - step frequency increases
- Step length increases - step frequency stays the same
- Step length increases - step frequency decrease

It is necessary to find a harmonious meeting point between the two factors as in the future will determine optimal performance, which can be achieved at any given time period.

From the difference condition to Bolt and Zohri's, on the step frequency where Zohri was better, compared to the step length where Bolt was superior. The fact is that the 100 meter run time is still big gap between Bolt: 9.58 seconds and Zohri 10.18 seconds

#### V. CONCLUSION

Assessing the two main factors determining the speed of 100 meters above can be concluded that the two factors have a very decisive role

Usain Bolt, who has a normal step frequency, is able to respond to the deficiency by having a very high step length as until now he is still holds the 100m runaway record, although he resigns in 2017 after the World Athletics Championship in London.

What is the chance of a 100m world record break? This will be very difficult to answer, unless a person with a high profile like Bolt but has a better step frequency for sure.

On the other hand, how are Zohri's opportunities to improve with his current condition? To improve Zohri's achievements it is much easier to do by means of simply improving and increase by increasing step length without reducing the step frequency and that can increase the step frequency simultaneously with its step length..

#### REFERENCES

- Ross, A., Leveritt, M., & Riek, S. (2001). Neural influences on sprint running. *Sports medicine*, 31(6), 409-425.
- Usherwood, J. R., & Wilson, A. M. (2005). Biomechanics: no force limit on greyhound sprint speed. *Nature*, 438(7069), 753.

- [3] Buckley, J. G. (1999). Sprint kinematics of athletes with lower-limb amputations. *Archives of physical medicine and rehabilitation*, 80(5), 501-508.
- [4] Slawinski, J., Bonnefoy, A., Ontanon, G., Leveque, J. M., Miller, C., Riquet, A., ... & Dumas, R. (2010). Segment-interaction in sprint start: Analysis of 3D angular velocity and kinetic energy in elite sprinters. *Journal of biomechanics*, 43(8), 1494-1502.
- [5] Chumanov, E. S., Heiderscheit, B. C., & Thelen, D. G. (2007). The effect of speed and influence of individual muscles on hamstring mechanics during the swing phase of sprinting. *Journal of biomechanics*, 40(16), 3555-3562.