

**DISSERTATION ASSESSMENT PROFORMA:**  
Empirical <sup>1</sup>

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Comments	Section		
	<b>Title and Abstract (5%)</b>		
	Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the empirical study undertaken.		
	<b>Introduction and literature review (25%)</b>		
	To include: outline of context (theoretical/conceptual/applied) for the question; analysis of findings of previous related research including gaps in the literature and relevant contributions; logical flow to, and clear presentation of the research problem/ question; an indication of any research expectations, (i.e., hypotheses if applicable).		
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	different elements of the data reported; discussion of the real-life impact of your research findings for coaches and/or practitioners (i.e. practical implications); discussion of the limitations and a critical reflection of the approach/process adopted; and indication of potential improvements and future developments building on the study; and a conclusion which summarises the relationship between the research question and the major findings.
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**ANALYSIS OF SCORING OPPORTUNITIES IN  
TAEKWONDO**

**(Dissertation submitted under the discipline of  
Performance Analysis)**

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ANALYSIS OF SCORING OPPORTUNITIES IN TAEKWONDO



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# Abstract

The purpose of this study was to analyse and compare the strategies between genders and the attacking strategies employed by elite taekwondo competitors. The type of attack, side of the body used to execute the attack, the height at which the attack was aimed and whether the attempted attack was successful or unsuccessful were recorded. A mixture between hand and computerised notation system was used to gather information for each athlete and documented on a pre-designed coding template. The data was collected post fight using pre-recorded competitive bouts. Reliability measures were completed with intra operator reliability, resulting in the test being found as reliable. The results were analysed using the Mann-Whitney U test that compared the genders. The conclusion identified both genders use a similar strategic approach however females were more successful with the use of their left leg than males, and it also showed they were more successful with attacking techniques to the head than males. No significant differences ( $P < 0.05$ ) were found from the results for any of the action variables involved between genders.

The results indicated that males and females both have similar strategies and tactics towards their fight. Coaches and athletes can derive much from this information, which includes highlighting the athlete's weaknesses and identifying techniques and skills that can be improved and addressed in training. Analysing weaknesses can be beneficial to the coach who can provide feedback to the athlete. Feedback can be generated for individual athletes either prior to, or after a competition, which will assist in developing their techniques and achievements.

# **CHAPTER ONE: INTRODUCTION**

## **CHAPTER ONE: Introduction**

### **1.1 Taekwondo**

Originating over 120 centuries ago in the 6<sup>th</sup> century B.C., taekwondo derived from South Korea as a martial art form (Casolino *et al.*, 2012). 'Taekwondo' literally means the art of kicking and punching; 'tae' directly translates as 'to hit using the foot', 'kwon' is interpreted as 'to hit using the fist' and 'do' refers to 'the art' of the sport (Kazemi, Perri and Soave, 2010). Initially designed for warfare and self-defence, taekwondo has recently become a distinguished international sport and considerably more popular since it was officially introduced into the 2000 Sydney Olympic Games (Kazemi, Casella and Perri, 2009). The athletes whom compete in the Olympics participate in taekwondo within the World Taekwondo Federation (WTF), which is the International Federation (IF) governing the sport of Taekwondo and is also a member of the Association of Summer Olympic International Federations (ASOIF) (World Taekwondo Federation, 2013).

The individual competitors are distinguished during a fight by the colour of their corner: one contestant will wear a blue protective chest shield, and the other will wear red. The ring is a 10m x 10m area in which the competitors will fight upon. One fight consists of three rounds, which are two minutes each. There are four referees which judge the match: one is a centre referee, who manages the fight and gives any necessary penalties, and the other three are corner judges. The scoring procedure is an electronic scoring system and points are awarded as follows; one point for a valid attack to the trunk, two points for a valid turning kick to the trunk protector, three point for a valid kick to the head and four points for a valid turning kick to the head (World Taekwondo Federation, 2012).

The weight classes defining the divisions during the Olympic Games differ from the World Championships. The focus of this study is using data collected from the World Taekwondo Championships, Puebla 2013; therefore the weight categories used are classified below (see Table 1).

**Table 1.** World Taekwondo Championships 8 weight classes

<b>Weight Category</b>	<b>Men</b>	<b>Women</b>
Fin	-54kg	-46kg
Fly	54kg-58kg	46kg-49kg
Bantam	58kg-63kg	49kg-53kg
Feather	63kg-68kg	53kg-57kg
Light	68kg-74kg	57kg-62kg
Welter	74kg-80kg	62kg-67kg
Middle	80kg-87kg	67kg-73kg
Heavy	+87kg	+73kg

## **1.2 Purpose**

The purpose of this study was to examine the difference in scoring opportunities between male and female elite athletes within competitive taekwondo bouts. The analysis was carried out during competitions in order to ensure that the participants were exerting themselves to their full extent. Additionally, this is to guarantee that the results of this study would be valid and reliable as the individuals were subjected to similar conditions. Furthermore, the results of this study would help to bring a variety of training drills into practice due to being able to understand how and why other athletes perform their techniques in order to score points. This study will help to form an idea of the thought processes between male and female athletes which brings them to make a decision on which techniques and counter techniques to perform and why.

Taekwondo has seen a great increase in popularity in recent times, which therefore leads to a greater increase in the various areas of research involved with taekwondo. Many previous studies have focused on physiological characteristics necessary to be successful within taekwondo; however, there is a gap in research within the performance analysis area. This study uses a notational analysis system in order to gain information within performance analysis in taekwondo. An appropriate explanation of notation analysis data



enables a coach to provide suitable feedback, motivate athletes and monitor improvements through the athletes' entire season (Byra & Scott, 1983).

### **1.3 Practical Issues and Limitations**

The Taekwondo World Championships has the utmost elite of martial artists involved from all around the world. Due to the fact that each country will have its own specific training practices, with each coach implying his or her own original drills, every athlete will have different tactics with reference to scoring opportunities which suggests that there may not be a clear significant result. Each individual athlete will have their own game plan in mind, in which they will be hoping to successfully put into practice. Due to the individual differences within this study, every possible technique and approach will be catered for and acknowledged in order to ensure a full analysis of all the performances that take place. Furthermore, an external variant which cannot be altered are the participant's opponent's counter techniques because it is their immediate and well informed reaction in order to defend themselves and reduce any chances of losing points. Additionally, the analysis of the fights will occur from one camera angle only. This could lead to a limitation in this research due to the fact that there is a possibility of missing certain points being scored or mistaking one technique for another, as it will not be fully feasible. Conversely, using only one camera from the same angle ensures the study is kept impartial.

### **1.4 Delimitations**

The research in this study has been delimited due to the fact that the individuals used are an exclusive and specific population. Only elite athletes that had partaken in the quarterfinals, semi-finals and finals of the Taekwondo World Championships 2013, Puebla, were used as participants in this particular study. The analysis has taken place with use of the most recent World Championships, which ensures that the results will denote the current training programmes and drills used by coaches and athletes. Therefore, the data collected from this study will be contemporary and can be used to enhance future athletes and their training programmes.

## **1.5 Aims and Intentions**

The particular areas of this research will focus on the exact techniques used within the final rounds of the World Championships. The main aims and objectives are to assess the differences between the attacking strategies employed by male and female elite taekwondo competitors.

### **1.5.1 Specific Objectives**

The specific objectives that the emphasis of the study will be upon are:

- The comparison of techniques performed by male and female competitors
- To identify the dominance of specific techniques used within a World Championship competition
- To recognise how many attempted techniques make contact and score

## **CHAPTER TWO: LITERATURE REVIEW**

## **CHAPTER TWO: Literature Review**

### **2.1 Performance Analysis in Sport**

Sports performance analysis is interdisciplinary and challenges unambiguous and precise definitions (Sampaio, McGarry and O'Donoghue, 2013), which aids the development and progression of sports performance. The aim of performance analysis is to inform the athletes and coaches of relevant feedback within competitive sport or during training. Furthermore, biomechanists and notation analysts are two different areas of expertise which both use performance analysis in order to improve an athlete's sport performance (Hughes and Bartlett, 2008).

Performance analysis is needed during the coaching process in order to assist a coach and ensure that any major or particular aspects of a performance development are not missed, which would be essential to improve an athlete's or team's performance. Information that is provided to coaches and athletes with the help of performance analysis support can be predominantly classified as quantitative and qualitative (O'Donoghue & Mayes, 2013).

Providing feedback to the athlete is a fundamental part of the coaching process if an individual is to improve their performance (Maslovat and Franks, 2008). Accurate interpretation and understanding of performance analysis data allows a coach to provide an appropriate level of feedback to the athlete. This would ensure that the athlete receives sufficient feedback, without overloading the individual with information, in order to focus on a certain feature of their training and develop their performance. Therefore, performance analysis can provide the coach with a valuable insight into the athletes' strengths and limitations in order to understand which specific disciplines and drills demand a greater quantity of practice time allocated during training.

Understanding the various premeditated and tactical methods used by an individual within a taekwondo competition as well as the physiological, psychological, technical and tactical demands that appear within the sport is of importance to develop the knowledge of coaches (Falco *et al.*, 2012).

Additionally, this will enable an enhanced understanding and ensure a variation of drills and vigorous training practices are put into place that will allow the athletes to train commendably for competitive situations.

## **2.2 Reliability**

O'Donoghue and Longville (2004) suggested the use of consistency checking within performance analysis which would improve the reliability of data collected from the athlete's performance using a performance analysis system before processing the data. To ensure an adequate reliability is consistent throughout this study, the data collected during the pilot study will be obtained twice; each a week apart, and a reliability test conducted upon this data.

The pilot study allows for the reliability test to be completed, which will permit the actual study to be positively reliable when extracting data. This will assist in highlighting individual operational definitions that will be focused upon, ensuring the results are flawless and clearly comprehended when being interpreted. Furthermore, athletes and coaches would also be capable of understanding the information gathered, while working alongside a performance analyst. Additionally, it is plausible that any anomalies that appear during the study could be based upon injuries or the athletes' mistakes, rather than the analysis of the performance itself. Furthermore, reliability and validity have a close connection with operational definitions. Hughes and Franks (2004) discovered that if there is any problem with reliability of data gathering, it is virtually constantly associated with the precision of the operational definitions.

Operational definitions must be clear and unambiguous in order to define a specific action (Hughes and Franks, 2004). Tables of the operational definitions used within this study are located in appendix A, B, C and D. These definitions allow all analysts, coaches and performers to be able to interpret all the actions within the performance in the same way. This is extremely useful within this study due to the fact that there are numerous techniques that the athletes can use, however some are quite similar which could cause misunderstanding or incorrect analysis of the performance. The indicators used during this study are known as

scoring indicators and quality indicators that show the quality of the athlete's performance. Scoring indicators within this study include; kicks, punches, feign, the ratio of points to errors and also successful compared to unsuccessful shots at the target. The quality indicators used in this study include; the amount of shots to target, overall shots in a round and amount of head shots. Performance indicators will be used to aid the analysis of the athlete's performances.

Performance indicators assist analysts and coaches in highlighting and identifying strong and weak techniques of an individual or team performance, and to facilitate a comparative analysis of individuals, teams and players (Hughes and Bartlett, 2004). Furthermore, Hughes and Bartlett (2004) imply that notational analysts have concentrated on general match indicators, tactical indicators and technical indicators which therefore contribute to the understanding of the different physiological, psychological, technical and tactical demands of the sports being analysed.

### **2.3 Feedback**

Feedback is information that refers to how a skill or action has been performed which can promote learning in the athlete, therefore ensuring a correct development of the technique in question (Hendry & Hodges, 2013). Without any feedback given to the athlete, no change in performance will occur: this can only be facilitated if an athlete's performances are subjected to a vital process of analysis (Hughes and Bartlett, 2008). Furthermore, Newell (1981) stated that accurate information about a specific performance would produce substantially more benefits for the athletes than the effects of imprecise feedback.

One of the benefits of video technology is the depth of information that can be utilized once analysed, whereas without the use of video-technology, feedback to the athlete can have a considerably worse effect. However, a videotape of an athlete's performance should be used in conjunction with the coach who is able to draw the athlete's attention to significant critical features of the actions after a full analysis (Franks, 2004). Film footage is essential due to the great difficulty of collecting precise and accurate data 'live' as taekwondo athletes must be able to

move with high velocity, speed, and power (Kazemi, Perri & Soave, 2010), which would noticeably impact on the results within the study being conducted.

## **2.4 Notation Analysis**

Notational analysis research has assisted the development of many sport analysis systems to rationalise in detail the performances of athletes in competition (Liebermann *et al.*, 2002). Notational analysis is an objective way of recording an athlete or team members actions, to ensure that meticulous events in a performance can be analysed in a consistent and reliable approach: this is to ensure that both the quantitative and qualitative feedback is accurate and impartial (Hughes and Bartlett, 2004). Notational analysis can provide both overarching feedback and specific developmental points, which perhaps target individual areas. With an athlete having to focus on improving the smaller details of their performance, this is more tangible to be achieved than having a vague indication of what the coach would like to be accomplished. Taekwondo athletes can benefit from notational analysis due to the fact that their performances can be broken down in detail and therefore the weaker variables of their performance can be improved upon.

Messersmith and Bucher (1939) were the very first analysts to attempt to invent a notation system exclusively for sport analysis. Their method was based upon the analysis of the distance covered by individual basketball players during a match. However, Fullerton (1910), was found to have the earliest publication specifically in the notation of sport. This research explored the different combinations of baseball players batting, pitching and fielding and the possibilities of success. Furthermore, Purdy (1977) discovered that notation systems were available to the public for commercial use for the analysis of American football as early as 1966. This has led to the use of notation systems within game and competitive situations in most sports in order to aid the athlete's knowledge and therefore develop their performance. Although some sports have very little performance analysis research published, it does not mean that notational analysis systems do not exist or are not used within these disciplines (Hughes and Franks, 2004). This is true of taekwondo: very little research has been done into the specific analysis of

individual athletes and their scoring opportunities. This particular study has its own specific notational analysis system in order to ensure all aspects of the athlete's performance are covered with the detail needed to analyse the performances effectively and reliably.

## **2.5 Hand Notation vs. Computerised Notation**

Reilly and Thomas (1976) and Sanderson and Way (1979) developed early templates of hand notation systems, however, Hughes and colleagues (Hughes, 1985; Hughes and Chalish, 1988; Hughes and Cunliffe, 1986; Hughes and Franks, 1991; Taylor and Hughes, 1988; Hughes and Knight, 1995; Hughes, 1995b) produced computerised notation systems for most sports. Both hand and computerised notation systems have now been applied to virtually every sporting situation that can provide extremely vital data to coaches and athletes alike.

Hand notation systems are generally very precise if the user inputs the correct data. However, some of the sophisticated hand notation systems involve considerable learning time in order for the correct use of the system; also the processing of the data gained involves many man-hours of work to ensure that the results are clearly understood by all involved in the performance analysis process (Hughes and Franks, 2004). The use of computerised notation systems eradicates complications associated with a hand notation system and also provides numerous opportunities within performance analysis.

Franks *et al.* (1983a) suggested the computerised notation system was more powerful than the hand notation system due to several clarifications; it can provide immediate feedback; it can aid in the development of a database; it can indicate the areas requiring improvement; it can deliver a quick evaluation of performance and can also be used as a mechanism for selective searching through a video recording of a performance. Despite bringing many positives into a performance analysis system, a computerised notation system likewise has several disadvantages. Increases in error possibilities are heightened due to an operator error, or hardware or software system error (Hughes, 2008). However, as



computers develop, the error possibilities should also become less frequent and the operator error should also diminish.

During this study a combination of both hand notation and computerised notation systems will be utilised. This will guarantee the data collected is considerably more precise and accurate as there will be significantly less risk of human error able to take place. Dartfish EasyTag is an app for smartphones and similar devices, which is an add-on to the Dartfish software that helps to capture and record information during a game or athlete's performance, allowing substantial timesaving during the post analysis (Dartfish, 2013).

Dartfish EasyTag permits the user to take e-notes while remaining focused on the performance and also facilitates the review and analyses after the data collection has taken place. This software is appropriate for this study due to the fact that it will reduce the chance of human error compared to that of a hand notation system used within this procedure. This method facilitates an accurate analysis of the athlete's performance and ensures no incorrect information will be discussed between the analysts, coaches and athletes. Furthermore, this also impacts in enabling for a quicker sharing of the information collected and analysed. The data could also be filtered, for example by type of technique or height of the technique, which would ensure a quick and effective process of reviewing important information.

## **2.6 Techniques and Skill in Taekwondo**

In taekwondo, kicking actions are classified as being: circular, targeting the lateral side of an opponent, linear aimed to the opponent's anterior end, and finally rotational which are performed with a spin previous to the kick (Serina & Lieu, 1991). With the various kicking actions, come many individual techniques (stated in Appendix A), and also leads to a different quantity of points being scored. The location of where the kick lands determines how many points are scored from this: one point is gained for a successful attack on the trunk protector, two points are given for a valid spin kick to the protector, three points for a kick to the head and

four points are awarded for a successful turning kick to the head (World Taekwondo Federation, 2013).

Bridge *et al.* (2011) stated that the turning kick is the most used technique in a taekwondo bout. However, unfortunately there is no information available concerning the leg (i.e., rear or front) used to perform this particular kick. During this study, while the performance indicators and operational definitions will cover the whole variety of techniques used by the athletes, the leg that is used by the individual will also be noted. This is to ensure a full analysis can occur, enabling the coach to fully understand the strengths of the athlete and any improvements required to be focused on and practiced during training.

## **2.7 Match Analysis in Martial Arts**

In order to analyse a sport effectively, video-based equipment is one of the foremost ways in doing so. It can be concluded that there is currently no specific systematic match analysis software that exists for martial arts (Witte, 2013). Individual martial arts, or specific competitions, have a particular analysis system in use but an overall software system for martial arts is not currently available.

Marcon *et al.* (2010) implemented a video analysis by means of a self-developed specific judo analysis software system SAATS (Structural Analysis of Action and Time in Sports), which calculates the exact duration of activities; this therefore allows an analysis of specific actions. Within Judo, this particular software is of great importance in notational analysis and assists the coaches to fully evaluate the performer's actions during specific performances. Furthermore, the study being conducted will hopefully develop a similarly structured and successful system in order to be put into use in the future to aid taekwondo coaches and analysts to improve the performance of taekwondo athletes.

Boxing is another sport in which notational analysis has been carried out. Ashker (2011) researched the technical and tactical aspects that differentiate between a winning and losing performance in boxing. The results of this study were to show that winners were more highly developed than the losers of fights specifically in

the following performance indicators; performing the offensive skills which were directed to the head and body, the total of the lead and rear hand punches, boxing combinations, defensive skills, and technical performance effectiveness. This study will be similar to the ideology behind Ashker's study, as the differences between the winners and losers, however also between male and female, will be shown within the results. Nevertheless, the performance indicators will have a much greater variety within the notational analysis system used.

## **2.8 Aim of the Study**

The aim of this study was to analyse the scoring opportunities of male and female taekwondo athletes in the World Championships within the final rounds of competition. There is an emphasis on; which leg the attack is from, the type of the attack, the height of the attack, whether it was a successful or unsuccessful attack and also if it was an attacking or counter-attacking situation.

## **CHAPTER THREE: METHOD**

## **CHAPTER THREE: METHOD**

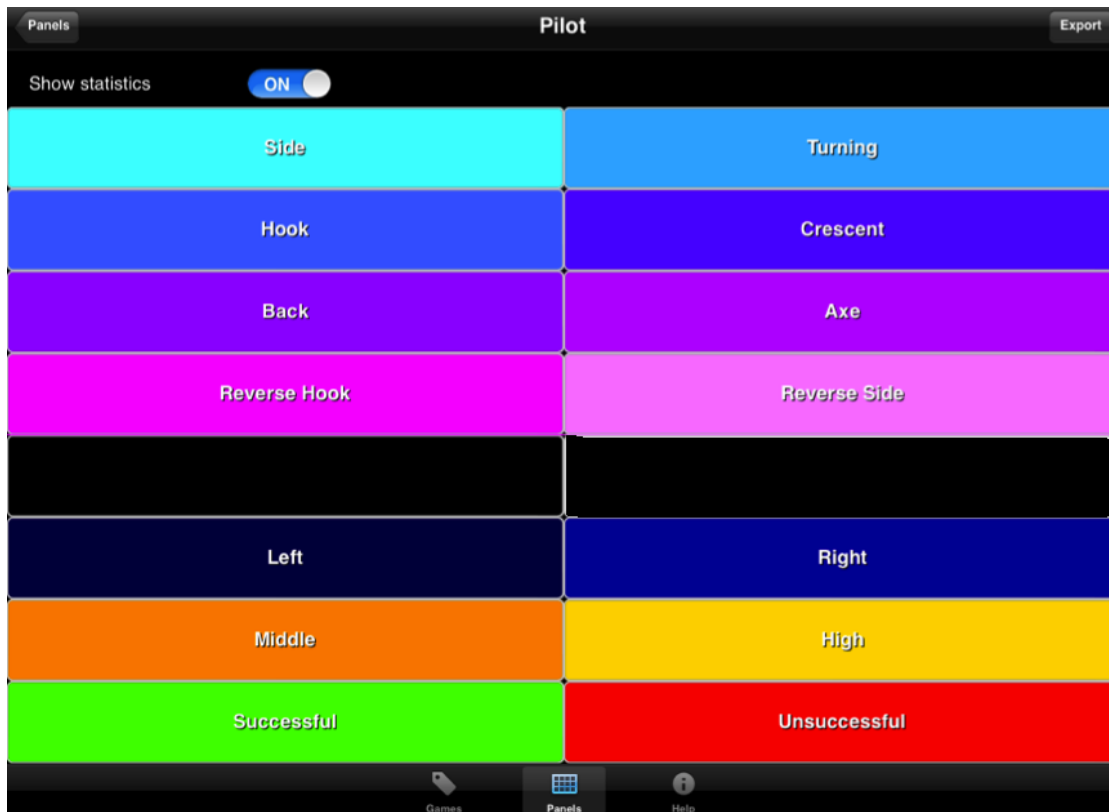
### **3.1 Introduction**

In order to ensure the correct data to be collected, a notation system was attentively planned, devised and experimented. The pilot study carried out identified problems with the method, which were rectified before the main investigation was completed.

### **3.2 Pilot Study**

During the pilot study, a total of 4 fights, 2 male and 2 female, were observed and analysed, with the procedure implemented to ensure that no faults would take place during the actual study. The bouts used throughout the pilot study were selected at random from the footage obtained from the 2013 World Taekwondo Championships. The fights were analysed once, and then again a week later. This was to aid the completion of the reliability testing to ensure the method was reliable and accurate.

Furthermore, the pilot study was of great use to ensure that the Dartfish EasyTag template was correctly set up with all the correct action variable buttons in use for the study. A coding template was created, which is shown below in Figure 1, in order to correctly identify the order and different techniques each athlete executed. The fights were all viewed in slow time, with it being paused to ensure a correct identification of the action variable being completed.



**Figure 1.** Pilot Dartfish EasyTag coding template

This allowed an identification of mistakes made in the first template: the ‘feign’ button had not been included in the original template design, which is a key feature necessary for an accurate analysis. Also, a ‘new round’ button had been added into the design after the pilot study had been completed in order to identify between the different rounds within a fight. This is of great use to both the coaches and athletes in aiding the understanding of the tactics and techniques and also any fatigue experience by the athlete during a fight.

To export data from the Dartfish EasyTag system, the report from the analysis could simply be emailed and opened up in Microsoft Excel. The data can then be organised and arranged into each technique, side, height and whether it was successful or unsuccessful. From this, the performance indicators can then be figured out.

### 3.3 Sample

Previously videoed footage from the 2013 Taekwondo World Championships held in Puebla was analysed for this study: the competitors involved in this tournament are the utmost elite athletes currently within taekwondo. The footage used was taken from 'www.dartfish.tv'. A total of sixteen, male (n=8) and female (n=8), taekwondo athletes will be analysed, using footage only from the semi-final and final rounds within this tournament.

**Table 2.** Fights used for analysis

Male	Division	Female
Kim (KOR) v Hsu (TPE)	-54kg Fin -46kg	Kim (KOR) v Valueva (RUS)
Cha (KOR) v Villa (MEX)	-58kg Fly -49kg	Sonkham (THA) v Aguirre (CUB)
Lee (KOR) v Mendoza (MEX)	-63kg Bantam -53kg	Kim (KOR) v Zaninovic (CRO)
Asbaghikhanghah (IRN) v Kim (KOR)	-68kg Feather -57kg	Kim (KOR) v Hamada (JPN)
Adriane (MEX) v Gaun (RUS)	-74kg Light -62kg	Marton (AUS) v Kim (KOR)
Guelec (GER) v Kotkov (RUS)	-80kg Welter -67kg	Niare (FRA) v Anic (SLV)
Castillo (CUB) v Ma (CHN)	-87kg Middle -73kg	Hernandez (CUB) v Lee (KOR)
Obame (GAB) v Mardani (IRN)	+87kg Heavy +73kg	Ivanova (RUS) v Acosta (MEX)

### 3.4 Performance Indicators

Every technical aspect used within taekwondo observed within this procedure was considered as a performance indicator, and within these are the action

variables operational definitions to describe and clearly state each specific factor. This will help to understand the athletes' method in which techniques and counter techniques are applied; including the attempted techniques, which will be broken down into successful and unsuccessful techniques. The non-contact and feign techniques will also be noted due to the fact that these are significant skills within the tactics of an athletes 'game' in order to trick the opponent and therefore score an additional point after this tactic has been carried out. The left and right side of the body will also be observed to aid the understanding of the difference between left- and right-legged individuals. A martial artist's strategies will have to change depending on which leg of their opponents' is the stronger side. This will affect the research with regards to understanding if a difference lays between male and female athletes and which gender has a favour towards a certain side of the body, if any at all.

The performance indicators that will be focused upon are:

- Percentage of attacks scored by the athlete compared to attempted number of attacks
- Percentage of attacks attempted and scored with the left side compared to the right side
- Percentage of attacks attempted and scored high section

### **3.5 Action Variables**

The action variables used are listed and the operational definitions regarding each are described in appendices A, B, C and D. This helps to ensure that the results of the study are as objective and unambiguous as possible. The action variables and the operational definitions used were formed with the use of 'Talk Taekwondo Guides' classifications and the 'World Taekwondo Federation' guidelines. Table 3 below represents the chain of notation of the action variables.



**Table 3.** The chain of notation of the action variables

<b>Action Variable</b>	<b>Intention</b>
Technique	Due to the great variety of techniques used within taekwondo it is of great importance to clarify the definitions of each specific techniques to enable no subjectivity within the study.
Side of the body	The side of the body used for the attack is noted to gain an understanding if there are any differences between males and females, also if the athlete has a stronger or preferable side of the body in which to attack with.
Height	The height of an intended attack is of importance due to the different amount of possible points gained for different techniques. This will be identified to gain an understanding of the athlete's process of attacking.
Successful or unsuccessful attack	It is of great importance to note the unsuccessful attacks along with the successful ones in order to understand what areas the athlete needs to develop upon.

### **3.6 Template Design**

Developing a coding template facilitates the collection of footage based on the performance indicators required for analysis. The software used to commence this was Dartfish EasyTag. In order to achieve this, a code window that contains numerous buttons relating to the performance indicators and action variables are specifically programmed. Each action variable will have it's own button with a specific label to identify the correct techniques used during analysis. Furthermore, each button will be colour coded in order for an easier identification in the analysis process. The template design used is shown below in Figure 2.



**Figure 2.** Dartfish EasyTag coding template

### 3.7 Procedure

Prior to each analysis of the different fights, the template in Easy Tag was adjusted slightly with the different athlete's name, country, weight category and gender in order to benefit the analysis of the results. The order in which the actions were notated remained constant throughout the data collection process.

The video footage was observed and analysed in lapsed-time, which ensured a greater detail and accuracy of the analysis. The order in which the actions were notated remained constant throughout the data collection process:

- 1) Type of attack
- 2) Side of the body
- 3) Height of attack
- 4) Successful or unsuccessful

All of the recorded data is then automatically transferred into Microsoft Excel that shows all of the information gained from the analysis of the fight. This reduces risks of human error that could take place when using a hand notation system.

### 3.8 Reliability

#### 3.8.1 Testing

An intra-operator reliability test was completed during this study before any data collection commenced in order to test the level of validity. For the testing of reliability a total of 4 athletes were analysed during competing at the World Taekwondo Championships. This sample was tested and the analysis carried out twice, with a week between each analyses.

**Table 4.** Reliability test fights

Male	Division	Female
	-58kg Fly -49kg	Sonkham (THA) v Aguirre (CUB)
	-63kg Bantam -53kg	Kim (KOR) v Zaninovic (CRO)
Asbaghikhanghah (IRN) v Kim (KOR)	-68kg Feather -57kg	
Guelec (GER) v Kotkov (RUS)	-80kg Welter -67kg	

The reliability test used was Kappa: this established the proportion of cases where the independent observers agree, excluding the ration where the agreement could possibly have been chance (O'Donoghue, 2007). The kappa value obtained from this analysis determines the reliability levels and whether the independent observers agree or not: the value of the kappa statistic varies from 0 to +1.0. Altman (1991) specified that a kappa value of 0.8 or above displayed a

very good strength of agreement and that a kappa value between 0.6 and 0.8 indicated a good strength of agreement.

### 3.8.2 Results

Table 5 below shows Altman’s (1991) interpretation of the levels of the kappa values, which was used to assess the intra-operator strength of agreement.

**Table 5.** Altman (1991) kappa values and strength of agreement

Kappa Value	Strength of Agreement
0.8 – 1.0	Very Good
0.6 – 0.8	Good
0.4 – 0.6	Moderate
0.2 – 0.4	Fair
0.0 – 0.2	Poor



**Figure 3.** Average intra-operator reliability

### 3.9 Data Processing

Data manipulation was conducted in Microsoft Excel, which was then imported into SPSS 20 for statistical analysis. Mann-Whitney U test were completed to

assess the level of significant differences between the data collected for each performance indicator in relation to gender. Levels of significance were set at  $p < 0.05$ .

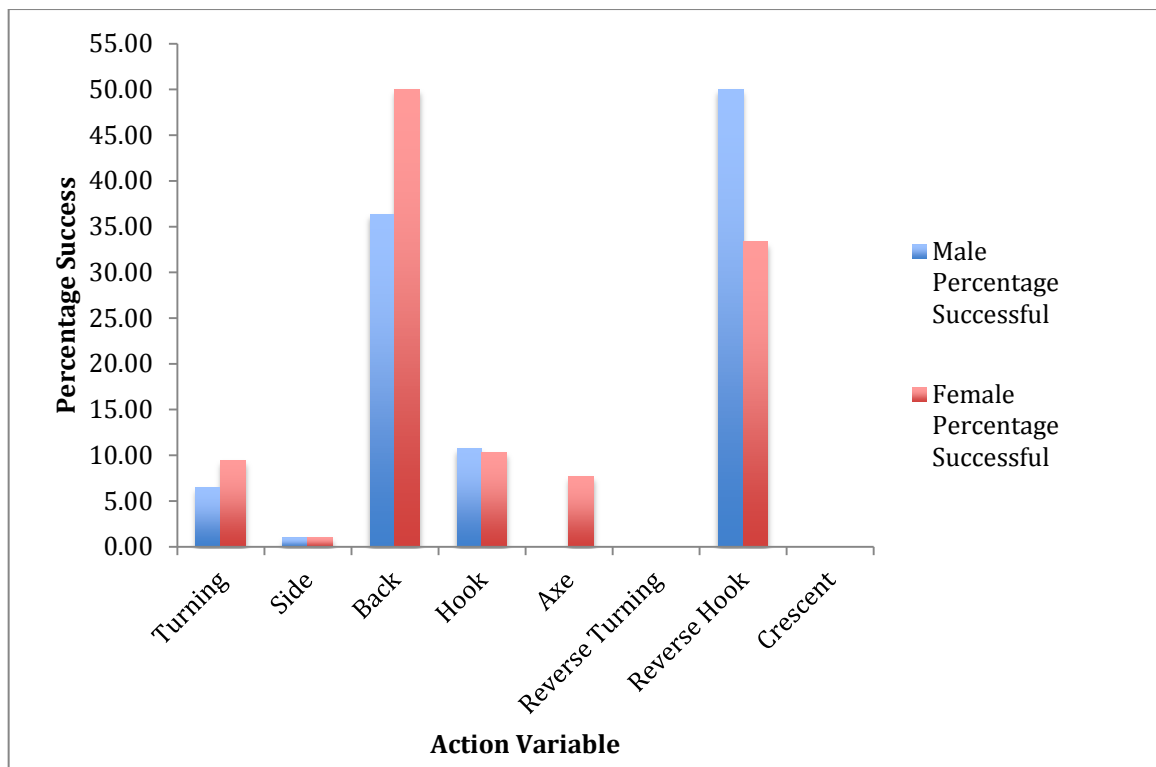
## **CHAPTER FOUR: RESULTS**

## **CHAPTER FOUR: Results**

### **4.1 Main Study Results**

In this chapter, the results from the study will be illustrated and highlight the important discoveries. It will also display any statistically significant differences and comparisons found between the strategies in male and female taekwondo athletes, which will be presented through tables and graphs. The statistical test applied within the study is the Mann-Whitney U test, with the main purpose to compare between the two genders. The results from the main study can be found in Appendix F.

Figure 4 clarifies the percentage success of the overall attacks, directly comparing the genders. Both males and females use the turning kick a significantly higher number of times than the other action variables. However, both the back kick and reverse hook kick have the highest percentage success rate in both genders. Furthermore, no significant differences were identified ( $P > 0.05$ ).



**Figure 4.** Percentage success for overall attacks comparing male and female

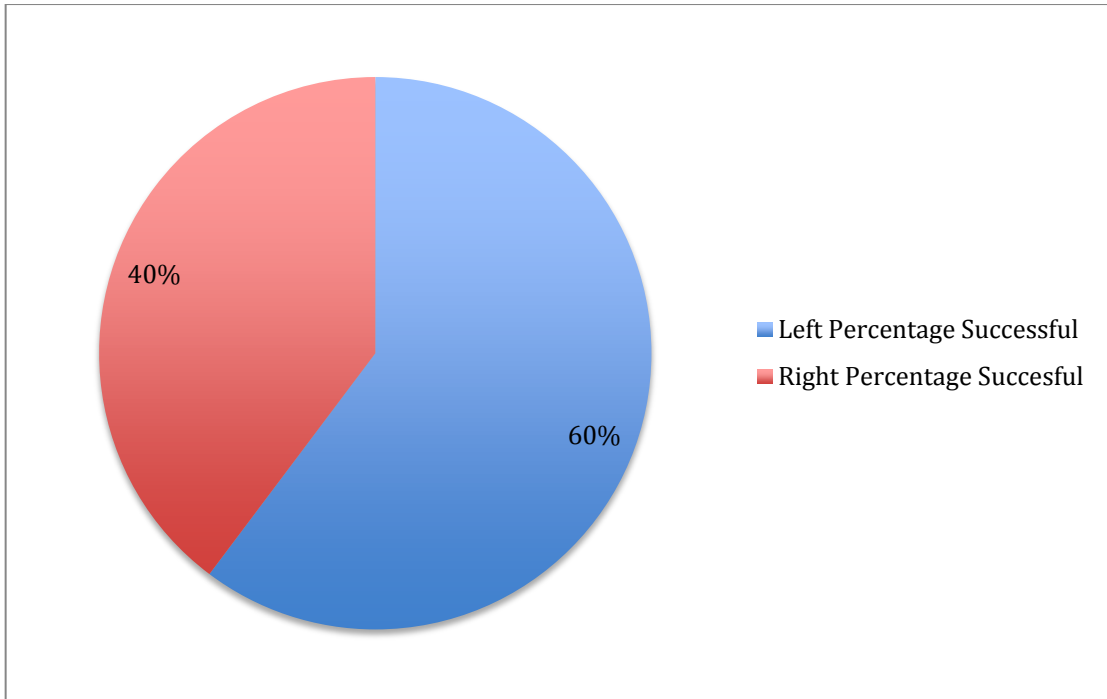
Table 6 shows the mean breakdown for the action variables for the entire sample. In both genders the turning kick was the most frequent and the most successful. The least frequent for the males was the reverse hook kick, but the least successful was the axe kick, reverse turning kick and crescent kick. However, in the females, the least frequent kick was identified as both the reverse hook kick and crescent kick: the reverse turning kick and crescent kick were also the least successful. Males showed a higher mean value of the usage with the left leg, whereas females displayed a higher mean value with the usage of their right leg, the same was identified with the success rate with the different legs. Furthermore, middle section kicks were recognised with the highest mean value in both genders.



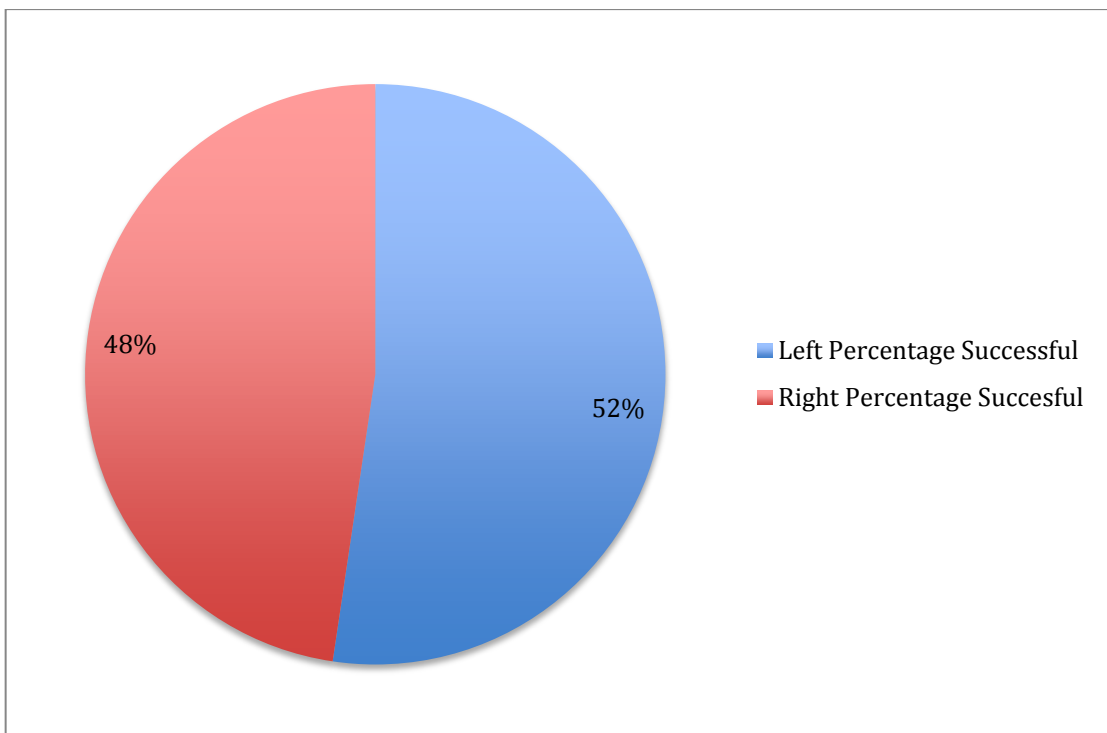
**Table 6.** Mean and standard deviation breakdown for action variables

Action Variable	Mean ( $\pm$ SD)			
	Male Attempted	Male Successful	Female Attempted	Female Successful
Turning Kick	42.13 ( $\pm$ 15.76)	2.75 ( $\pm$ 2.66)	35.75 ( $\pm$ 13.67)	3.38 ( $\pm$ 2.26)
Side Kick	12.88 ( $\pm$ 11.00)	0.13 ( $\pm$ 0.35)	11.75 ( $\pm$ 5.63)	0.13 ( $\pm$ 0.35)
Back Kick	1.38 ( $\pm$ 2.07)	0.50 ( $\pm$ 0.76)	0.50 ( $\pm$ 0.76)	0.25 ( $\pm$ 0.46)
Hook Kick	3.50 ( $\pm$ 5.78)	0.38 ( $\pm$ 0.52)	3.63 ( $\pm$ 3.25)	0.38 ( $\pm$ 0.52)
Axe Kick	1.38 ( $\pm$ 2.00)	0.00 ( $\pm$ 0.00)	1.63 ( $\pm$ 1.60)	0.13 ( $\pm$ 0.35)
Reverse Turning Kick	0.50 ( $\pm$ 0.93)	0.00 ( $\pm$ 0.00)	1.75 ( $\pm$ 3.41)	0.00 ( $\pm$ 0.00)
Reverse Hook Kick	0.25 ( $\pm$ 0.46)	0.13 ( $\pm$ 0.35)	0.38 ( $\pm$ 0.52)	0.13 ( $\pm$ 0.35)
Crescent Kick	0.38 ( $\pm$ 0.74)	0.00 ( $\pm$ 0.00)	0.38 ( $\pm$ 0.52)	0.00 ( $\pm$ 0.00)
Left	38.50 ( $\pm$ 24.17)	2.75 ( $\pm$ 1.83)	19.50 ( $\pm$ 9.15)	1.63 ( $\pm$ 1.60)
Right	23.88 ( $\pm$ 20.07)	1.13 ( $\pm$ 2.03)	36.25 ( $\pm$ 15.65)	2.75 ( $\pm$ 2.05)
Middle	52.25 ( $\pm$ 19.02)	2.88 ( $\pm$ 2.30)	43.00 ( $\pm$ 11.50)	2.88 ( $\pm$ 1.55)
High	9.00 ( $\pm$ 7.43)	1.00 ( $\pm$ 1.07)	12.63 ( $\pm$ 6.86)	1.50 ( $\pm$ 1.31)
Feign	8.13 ( $\pm$ 5.36)	-	9.50 ( $\pm$ 5.21)	-
Total	61.25 ( $\pm$ 20.84)	3.88 ( $\pm$ 2.90)	55.63 ( $\pm$ 15.40)	4.38 ( $\pm$ 2.33)

Figure 5 and Figure 6 identify the percentage success of the left and right leg usage of both genders. It shows that despite the mean values, both genders have a higher success rate with their left leg. Males had a notably higher success rate with their left leg; however, there was no significant difference ( $P > 0.05$ ).



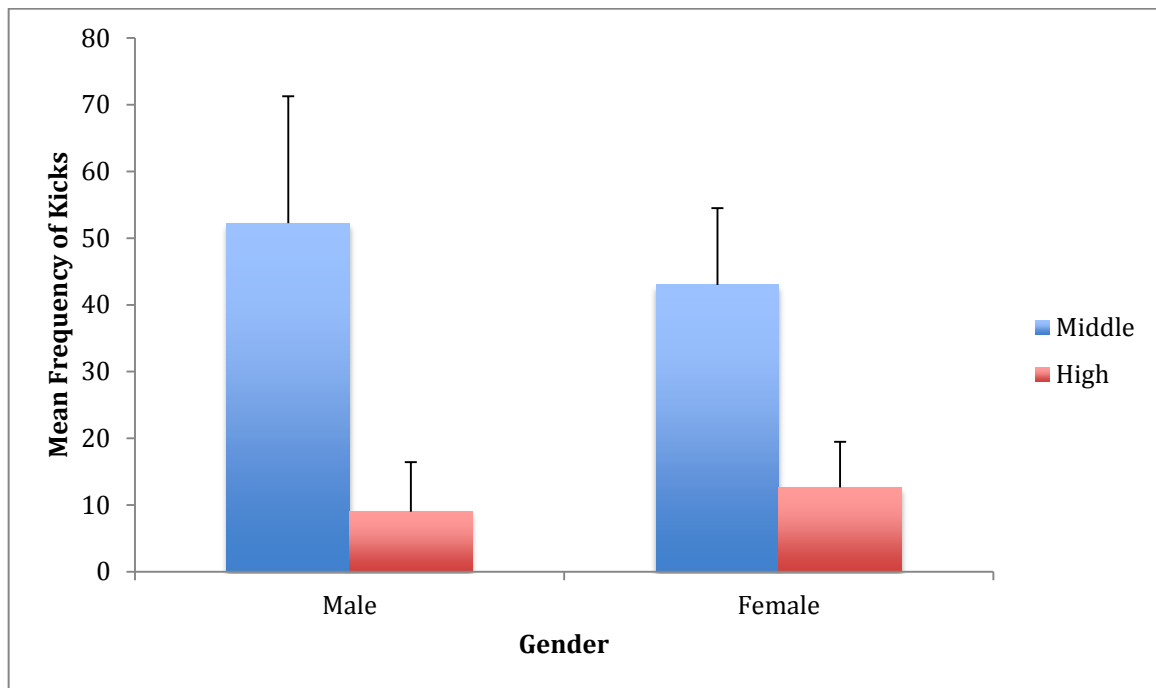
**Figure 5.** Percentage success rate comparing right and left leg in males



**Figure 6.** Percentage success rate comparing right and left leg in females

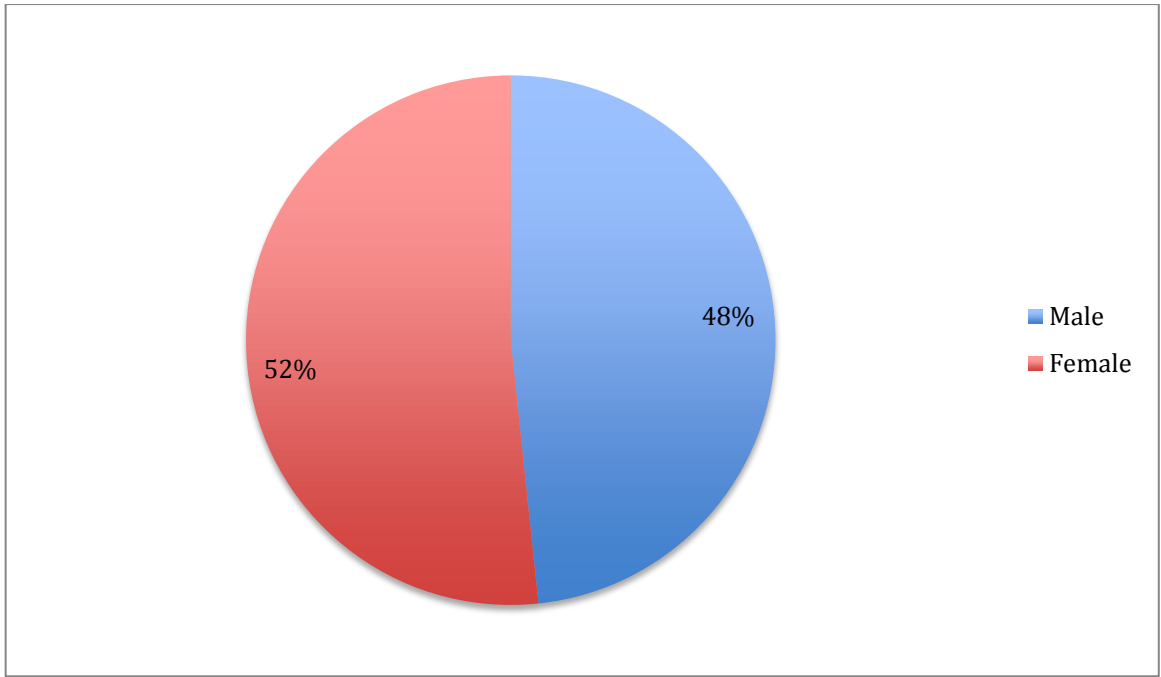
Figure 7 shows the mean difference between the genders and which section of the body the kicks were attempted at. The middle section was significantly higher

frequency of kicks compared to the high section. However, there is no significant difference ( $P>0.05$ ) between male and female athletes.



**Figure 7.** Mean and standard deviation for middle and high section attacks comparing genders

Figure 8 shows the percentage difference of success for high section kicks between the male and female athletes. There was no statistical significant difference between the genders ( $P>0.05$ ).



**Figure 8.** Percentage success comparing male and female for high section kicks

## **CHAPTER FIVE: DISCUSSION**

## **CHAPTER FIVE: Discussion**

This section will concentrate on the discoveries from the current investigation. Relevant, current and previous literature will review and underpin the findings from the results of this study. Reference to literature from other sports and martial arts will be applied where relevant due to the lack of literature available within taekwondo for some key areas of the discussion.

### **5.1 Introduction**

The aim of this study was to focus on the particular techniques executed within the final rounds of a recent taekwondo World Championships, comparing the male and female athletes to assess any difference in the strategies and tactics employed between the two genders. The study would provide an area of research within the performance analysis of taekwondo that has been lacking from any previous literature.

This study concentrated on the type of techniques, the height of the techniques executed and the side the technique was performed in elite taekwondo athletes. Previous literature by Marcon *et al.* (2010) was deemed relevant to the discussion area within this study as a similar design and action variables were used: however, as the previous research involved judo, a different template design and procedure was necessary. Hughes *et al.* (2002) stated that the most frequently used method in notational analysis is to record the occurrences of actions that relate to the outcomes of an athlete's performance.

### **5.2 Reliability**

James *et al.* (2007) stated that reliability within performance analysis is concerned with how accurate and precise the events that occur are coded. A reliable system is of great importance in performance analysis due to the fact that an unreliable system would produce inconsistent data, which proves detrimental to coaches and players alike (Hughes and Franks, 2004). This study encompasses intra-operator reliability testing, which demonstrates the reliability

of the system, shown in Table 3 and Figure 2. The results of the reliability test deemed this study as reliable and a pilot study was also conducted to test any faults or complications. Kappa values were used to establish the intra-observer agreement, which allows a detection of whether the system is reliable (Robinson and O'Donoghue, 2007). The results of the reliability test met the 'very good' level,  $k > 0.08$ , on the strength of agreement Kappa scale identified by Altman (1991). O'Donoghue (2006) acknowledged that a Kappa value equal to 0.8 or above are interpreted as a good strength of agreement and signify a reliable system.

### **5.3 Discussion of Findings**

The performance indicators used within this study are what are believed to be the most appropriate regarding the aim of the study. The performance indicators used in a similar study were identified as; the total of actions, type of action, type of kick, area of kick and the points obtained in the match (Falco *et al.*, 2012). The comparison of male and female taekwondo athletes can be easily made with the performance indicators used. Furthermore, there is very few literature reports with relevance to the performance analysis of the techniques executed in competitive taekwondo, and as Witte (2013) established, there is no match analysis software that currently exists for any martial arts.

#### **5.3.1 Overall Techniques**

The most dominant kick executed by both genders is the turning kick. Performed correctly, this is an incredibly fast kick and can be completed without much body movement. This ensures that the opponent is not likely to recognise the commencement of this attack, consequently a point is more liable to be scored. Furthermore, Casolino *et al.* (2012) conducted a study in which the results concluded that the turning kick was the overriding technique executed during both offensive and defensive actions. The subsequent dominant kick in both males and females alike is the side kick. Completed accurately, this is an effectual self-defence technique and can push the rival back with great strength.

Furthermore, this skill is also suitable to initiate a defence when you recognise the opponent's preparation to launch an attack.

The reverse hook kick is the technique performed the least in males. This skill is very challenging to time and execute correctly, but if done accurately, it can be very effective due to the power behind it and the 'surprise element' the opponent will experience. The second least performed kick by males is the crescent kick: this technique is not very common during a sparring bout but is used preferably as a blocking technique rather than an attacking skill. Furthermore, the females had a joint mean frequency of 0.38 (SD  $\pm$ 0.52), for both the reverse hook kick and crescent kick, showing a similar pattern as to the male gender.

Although the reverse hook kick was identified as the least performed by males it was in fact the most successful technique, with a 50% success rate. This attack was the least frequent, however it was the most precise and accurate skill, with the most points gained from this technique. Another successful kick the males completed was the back kick. By spinning and turning to perform this technique, the 'surprise element' will be upon the opponent who will be unaware of what they are about to face. This particular technique is also the most successful within the females, with the reverse hook kick also being their second most successful technique. Furthermore, for both genders the least two successful techniques are the reverse turning kick and the crescent kick, which have a zero percentage success rate. Additionally, the axe kick is a further technique that has a zero percentage success rate, but for the male gender only. This could be due to many reasons; the athlete could not be agile or fast enough to score from these, the opponent could anticipate the skill and counter attack it appropriately, or the skill was not performed correctly.

The genders have a similar strategic approach towards the scoring opportunities within a taekwondo bout. The most dominant kicks being one similarity, which is due to the fact that the turning kick and side kick are the techniques most effective of scoring and gaining points during a competition. Both of the dominant techniques are also an efficient defence mechanism and are taught extensively during training with specific drills and routines in which to implement the tactics



within the athletes. The similarities between males and females in the techniques that are executed the least demonstrate that they are not as fast and successful as the more dominant skills. Furthermore, the percentage of success for the back kick and the reverse hook kick is an additional similarity: this depicts that the athletes are more accurate when performing these techniques. The similarities discovered occur due to the training programmes implemented: both genders train and practice together, which would signify a similarity in the strategy behind their style and the success rates of the techniques performed.

The succession of the back kick and reverse hook kick is a difference between the genders. Females are more effective at scoring with the back kick, where as males are more successful with the use of the reverse hook kick. Males showed a zero percentage success rate with the performance of the axe kick, however females had a 7.69% success rate with this skill.

No significant differences ( $P < 0.05$ ) were identified from the results between the genders and this could be due to the fact the athletes train together. From a performance analysis point of view the results allow the coach and athlete to understand which individual techniques need practice during training. The coach could understand how the athlete is losing points and create a specific training plan.

Previous research has displayed that male competitors from the heavier weight divisions show a slower fighting style than athletes in the lighter division (Butios and Tasika, 2007). This could mean that the difference in weights has an impact upon how many techniques are actually performed during a bout, which would also have an influence on the physiology involved with the athlete's energy expenditure and fatigue. Furthermore, future studies could include the weights divisions within the performance indicators to establish and identify further comparisons and differences with male and female athletes.

### **5.3.2 Side of the Body**

Males use the left leg to execute techniques on average 62% more than their right leg. However, females have a 54% more usage of their right leg when compared to their left leg. This shows a distinct difference between the genders and which leg is preferred to execute skills.

Despite this, both genders are more successful with their left leg. Males have a 60%/40% split between the right and left leg success with the favour towards the left leg. Females have a lesser split with a 52%/48% difference with the left leg also being more successful. This shows that the left leg is the favoured leg to attack with, however individual differences have a large impact upon this. There is no specific leg that an athlete is taught to attack with; it is down to individual preference on what feels more comfortable and more powerful.

This allows an identification of a taekwondo performance focusing on which side of the body the techniques were executed from, indicating the stronger or superior side of the body. This would allow the coach and athlete to come up with a plan in order to alter training programmes to acquire a similar usage of the weaker leg. If both legs are of a similar power, it enables the athlete to be more agile which will allow a greater chance of scoring from either leg. Agility, reaction, speed, dynamic balance, and timing are of fundamental importance in martial arts to coordinate different sequences of techniques in relation to the opponent's behaviour (Sadowski, 2005).

### **5.3.3 Height**

Both genders showed preference towards the middle section in attempting techniques. Males attempted the high section with 17% of their techniques and females attempted it with a greater 29% of their techniques. Additionally, Falco *et al.* (2012) identified a similar result, with only 13% of the overall techniques aimed at the head for the males, and females only attempted 11% of their techniques at high section. Furthermore, females had a 52% success rate of

their attempted high techniques compared to the 48% for males. This shows that females are more accurate with their high section techniques.

Scoring a technique in the high section is desirable as more points are gained if a successful technique is executed. Neither gender would be able to constantly perform high section techniques to gain more points due to several reasons. This is because fatigue would set in quicker, which would be detrimental to the performance in the later rounds. Also, the opponent would be able to anticipate the athlete's game plan and strategy towards the fight enabling them to counter-attack effectively and successfully.

However, different combinations will provide a mixture of both sections. The first couple of techniques will be performed at middle section to put the opponent off guard in order to then score at high section. Future research could perhaps focus on the different combinations and how they affect opponents in relation to the height of the techniques.

#### **5.4 Sample Issues**

The size of the chosen sample is one of the issues that constantly arise in match analysis. It is debatable whether adequate data is collected to produce a meaningful representation of a performance. The study used sixteen different fights from the 2013 World Taekwondo Championships, which provides a reflection of the most elite taekwondo athletes in the World. Furthermore, in a similar study conducted by Falco *et al.* (2012) studying the match analysis in a university taekwondo championship, sixty-one athletes were used as participants. This sample size allows more generalisation to occur with the results, however the sample was not using as elite athletes as the current one. It was concluded that there was no significant difference between the genders within any of the performance indicators used: if a larger sample size was used the results may have displayed a differentiation. Furthermore, the footage used for this study was pre-recorded and analysed in lapsed time. However, one of the fights used consisted of a fourth 'sudden death' round, this is due to the fact that the final

score was a tie (which inevitably leads to a further two minutes or until the first point is scored), was used in the analysis.

## **5.5 Implications of Findings**

Atkinson (2003) stated that the practical purpose of conducting research is to create a valuable change in performance. Furthermore, Taylor *et al.* (2005) identified the various opportunities technical analysis has within the sporting world. Likewise, the analysis process can be used to evaluate tactical and technical abilities of athletes to provide a reliable indication of their performances. Falco *et al.* (2012) identified that the athlete position within the fighting area and relative to the opponent is yet to be explored which could have an impact upon the type of technique, the side of the body and also the height of the technique executed. This study provides a system that could be used to analyse and give feedback to taekwondo athletes and coaches.

The greatest use of this design would be for individual athletes due to the fact that there were no statistical significant differences between the male and female analysis. With the use of the template design in this study, if used on an individual athlete, the coach would be able to develop the athlete's strategies and tactics in the execution and scoring of techniques. Additionally, it is clear that creating an accurate analysis of technical actions can significantly influence coaching sessions (Bate, 1996).

This study presented a new area of research to the literature and also a set of performance indicators that can be used or developed for any future analysis within taekwondo. All of the results were presented in an athlete and coach friendly manner, which would allow for an ease of understanding progression and development upon their future training practices.

## **CHAPTER SIX: CONCLUSION**

## **CHAPTER SIX: Conclusion**

### **6.1 Conclusions of the Study**

The aim of this study was to devise and develop a notation system in which to compare the differences between the strategies and tactics between male and female elite taekwondo players.

The results gained displayed that there was no significant difference between the strategies behind male and female athletes. Different action variables were identified, which included the overall frequency of execution of techniques, the differences between the left and right side of the body and the height of the performed techniques. The successful techniques are the vital part, which is to be analysed in order to understand the areas of the athlete's performance that need focusing upon and developing.

The analysis of the technical performance identifies any similarities and differences between the genders. The overall execution of techniques and the success rates were both very similar; however, the usage of the left and right leg displayed that males prefer the left leg and likewise females prefer using the right leg. Nevertheless, both genders were more successful with the use of their left leg. A fundamental strength of this study was that every single technique, with different variables, could be recorded and subsequently analysed; if need be data could be further passed on to coaches and athletes.

More understanding of individual athletes would be gained if this system were to be used on a one-to-one basis instead of analysing a whole group of athletes. This would allow for a more in-depth analysis of specific athletes to enable an enhanced development within training.

### **6.2 Recommendations of Future Research**

The methods utilised in the current study have retrieved helpful findings with regards to the individual athletes' strategies and tactics towards their 'game plan'.

There are several limitations to this study and areas to further this report; the following recommendations have been noted:

- Developing the coding template and analysis system to allow for ease of data collection and analysis
- Comparing the execution of techniques with time-periods to fully understand the complete strategies from different athletes
- Assessing the technical performance in relation to a perfect model and how well the technical was executed
- It would be beneficial to identify the specific positions in which the performer is on the mat to aid the coach in identifying improvements for the athletes
- Associate the country which is being represented with the techniques and strategies used
- Compare the divisions of the athletes with the type and frequency of actions executed to understand differences in weight categories
- The method could be adapted to other martial arts to identify other strategies and tactics used in combat sports

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## **APPENDICES**

## Appendix A

**Table A.1.** Operational definitions of techniques

<b>Technique</b>	<b>Operational Definition</b>
Turning Kick	The knee is raised and the hips simultaneously turned 90 degrees to face the opponent, as the hips turn, the leg is kicked in the same direction to strike the side of the opponents body or head
Side Kick	The knee is raised up and almost simultaneously the body pivots 90 degrees so the hip on the kicking side is pointed towards the opponent, the knee is brought away from the opponent, the lower leg held parallel to the ground and the leg is thrust out sideways
Back Kick	Initiated the same way as the side kick but the hips are turned further than 90 degrees so that the opponent is viewed over the shoulder, the kick is then thrust out backwards
Hook Kick	The leg is lifted like a roundhouse kick but the hips are turned over 90 degrees towards the opponent so that the kicking leg is on the far side of the body, the outstretched leg is then rapidly bent inwards in a hooking movement
Axe Kick	The straightened kicking leg is swung directly up into the body of the practitioner, as its vertical apex the kicking lies flat along the practitioner, nestled into the same side shoulder, the straight leg then is brought down onto the head or shoulders of the opponent
Reverse Turning Kick	The back leg is the kicking leg, pivoting on 180 degrees on the front leg, spinning and chambering your leg, then straightening it out to kick with the heel.
Reverse Hook Kick	The back leg is the kicking leg, pivoting on 180 degrees on the front leg, the practitioner swings their

back leg behind themselves and towards their opponent, as the kicking leg foot approaches the opponent, the leg is bent inwards sharply to strike the back of the opponents head

#### Crescent Kick

Inside crescent kick- the knee is lifted high across the body in a tight arc shape, the kick originates outside the body and moves across in an arc

Outside crescent kick- works in the opposite way to the inside crescent kick, the leg swings in an arc from inside to outside

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## Appendix B

**Table B.1.** Operational definitions for height

<b>Performance Indicator</b>	<b>Operational Definition</b>
Body Shot	An attack that was aimed/landed anywhere between the hip and shoulder on the trunk protector <ul style="list-style-type: none"><li>- 1 point for a fist technique</li></ul> 1 point for a valid kick
Head Shot	An attack that was aimed/landed anywhere on the head <ul style="list-style-type: none"><li>- 2 points for a valid kick</li><li>- 4 points for a valid turning kick</li></ul>

## Appendix C

**Table C.1.** Operational definitions for side of the body

<b>Performance Indicator</b>	<b>Operational Definition</b>
Left	A technique performed from the left side of the body
Right	A technique performed from the right side of the body

## Appendix D

**Table D.1.** Operational Definitions of Successful or Unsuccessful Attacking

<b>Performance Indicator</b>	<b>Operational Definition</b>
Successful	A point(s) awarded for a correct technique landed on the opponent
Unsuccessful	No points given for an attempted technique

## Appendix E

**Table E.1.** SPSS Results Descriptive Statistics

<b>Descriptive Statistics</b>					
	N	Mean	Std. Deviation	Minimum	Maximum
Turning	16	38.9375	14.62632	18.00	68.00
Side	16	12.3125	8.45946	1.00	29.00
Back	16	.9375	1.56924	.00	6.00
Hook	16	3.5625	4.53091	.00	17.00
Axe	16	1.5000	1.75119	.00	5.00
RTurning	16	1.1250	2.50000	.00	10.00
SucTurning	16	3.0625	2.40745	.00	8.00
SucSide	16	.1250	.34157	.00	1.00
SucBack	16	.3750	.61914	.00	2.00
SucHook	16	.3750	.50000	.00	1.00
SucAxe	16	.0625	.25000	.00	1.00
SucRTurning	16	.0000	.00000	.00	.00
RHook	16	.3125	.47871	.00	1.00
SucRHook	16	.1250	.34157	.00	1.00
Crescent	16	.3750	.61914	.00	2.00
SucCrescent	16	.0000	.00000	.00	.00
Total	16	58.4375	17.93681	36.00	89.00
SucTotal	16	4.1250	2.55278	1.00	10.00
Left	16	29.0000	20.19901	7.00	83.00
SucLeft	16	2.1875	1.75950	.00	6.00
Right	16	30.0625	18.52734	2.00	64.00
SucRight	16	1.9375	2.14379	.00	6.00
Middle	16	47.6250	15.91592	25.00	78.00
SucMiddle	16	2.8750	1.89297	.00	7.00
High	16	10.8125	7.15746	1.00	25.00
SucHigh	16	1.2500	1.18322	.00	4.00
Feign	16	8.8125	5.15388	1.00	18.00

Gender	16	1.5000	.51640	1.00	2.00
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**Table E.2. SPSS Results Test Statistics**

**Test Statistics<sup>a</sup>**

	Turning	Side	Back	Hook	Axe	RTurning	SucTurn	SucSide	SucBack	SucHook	SucAxe	SucR Turning	RHook	SucR Hook	Crescent	Suc Crescent	Total	SucTotal	Left	SucLeft	Right	SucRight	Middle	Suc Middle	High	SucHigh	Feign
Mann-Whitney U	24	30	25	22.5	24.5	25	24.5	32	27	32	28	32	28	32	29.5	32	28	25.5	17	20.5	16	15.5	23	29.5	20	24.5	26
Wilcoxon W	60	66	61	58.5	60.5	61	60.5	68	63	68	64	68	64	68	65.5	68	64	61.5	53	56.5	52	51.5	59	65.5	56	60.5	62
Z	-0.84	-0.21	-0.82	-1.01	-0.82	-0.85	-0.8	0	-0.65	0	-1	0	-0.52	0	-0.32	0	-0.42	-0.69	-1.58	-1.24	-1.68	-1.79	-0.95	-0.27	-1.27	-0.85	-0.63
Asymp. Sig. (2-tailed)	0.4	0.833	0.415	0.312	0.413	0.396	0.42	1	0.519	1	0.32	1	0.602	1	0.747	1	0.674	0.489	0.11	0.216	0.093	0.073	0.344	0.787	0.2	0.396	0.528
Exact Sig. [2*(1-tailed Sig.)]	.442 <sup>b</sup>	.878 <sup>b</sup>	.505 <sup>b</sup>	.328 <sup>b</sup>	.442 <sup>b</sup>	.505 <sup>b</sup>	.442 <sup>b</sup>	1.000 <sup>b</sup>	.645 <sup>b</sup>	1.000 <sup>b</sup>	.721 <sup>b</sup>	1.000 <sup>b</sup>	.721 <sup>b</sup>	1.000 <sup>b</sup>	.798 <sup>b</sup>	1.000 <sup>b</sup>	.721 <sup>b</sup>	.505 <sup>b</sup>	.130 <sup>b</sup>	.234 <sup>b</sup>	.105 <sup>b</sup>	.083 <sup>b</sup>	.382 <sup>b</sup>	.798 <sup>b</sup>	.234 <sup>b</sup>	.442 <sup>b</sup>	.574 <sup>b</sup>

a. Grouping Variable: Gender

b. Not corrected for ties.

## Appendix F

Table F.1. Raw Results

Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<b>Gender</b>	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
<b>Turning</b>	68	39	65	33	35	41	29	27	44	25	25	49	36	18	31	58
<b>Successful Turning</b>	3	5	8	3	1	1	0	1	2	4	2	8	3	1	2	5
<b>Side</b>	4	25	19	29	2	17	1	6	11	9	8	8	24	8	10	16
<b>Successful Side</b>	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
<b>Back</b>	0	0	0	0	6	2	1	2	1	0	0	0	1	2	0	0
<b>Successful Back</b>	0	0	0	0	1	1	0	2	1	0	0	0	1	0	0	0
<b>Hook</b>	0	17	2	0	1	1	6	1	2	0	9	8	4	3	1	2
<b>Successful Hook</b>	0	1	1	0	0	0	1	0	0	0	1	1	0	1	0	0
<b>Axe</b>	1	4	1	0	5	0	0	0	2	1	1	0	0	5	2	2
<b>Successful Axe</b>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<b>Reverse Turning</b>	0	2	0	0	0	0	0	2	1	0	0	1	2	0	10	0
<b>Successful Reverse Turning</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Reverse Hook</b>	0	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0
<b>Successful Reverse Hook</b>	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
<b>Crescent</b>	2	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0

<b>Successful Crescent</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	75	88	89	62	49	52	37	38	62	36	43	66	68	38	54	78
<b>Successful Total</b>	3	6	10	4	2	2	1	3	4	6	3	9	4	2	2	5
<b>Left</b>	52	83	28	60	28	17	27	13	30	7	9	30	17	27	22	14
<b>Successful Left</b>	3	6	4	4	1	1	1	2	0	0	2	5	2	2	1	1
<b>Right</b>	23	5	61	2	21	44	10	25	32	29	35	36	51	11	32	64
<b>Successful Right</b>	0	0	6	0	1	1	0	1	4	6	1	4	2	0	1	4
<b>Middle</b>	70	63	78	61	44	48	27	27	49	25	31	45	55	34	50	55
<b>Successful Middle</b>	1	5	7	4	2	2	0	2	3	2	2	6	3	2	1	4
<b>High</b>	5	25	11	1	5	4	10	11	13	11	12	21	13	4	4	23
<b>Successful High</b>	2	1	3	0	0	0	1	1	1	4	1	3	1	0	1	1
<b>Feign</b>	7	8	1	18	4	13	5	9	6	9	12	10	15	17	1	6





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Date: 11 March 2014

To: Victoria Billington (st20007116)

Project reference number: 13/05/030U

Your project was recommended for approval by myself as supervisor and formally approved at the Cardiff School of Sport Research Ethics Committee meeting of 29th May 2013

Yours sincerely

A handwritten signature in black ink, appearing to read 'L. Adams'.

Supervisor

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