KIHECT AS A REHABILITATION TOOL TO IMPROVE THE ACCURACY OF HAND-EYE COORDINATION AMONG MALAYSIAN RUGBY JUNIORS

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All praises to Allah the Almighty
for the strengths and His blessing in completing this thesis.

To my lovely wife Naziha Jamaludin.
Beloved father Rozan Salleh,
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My wonderful daughter Rania Sumaiyah,
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ABSTRACT

The Kinect Hand-Eye Coordination Technology (KIHECT) device has been successfully developed as a rehabilitation tool to improve the accuracy of hand-eye coordination (HEC) among Malaysian junior rugby players. Ninety rugby players from Sekolah Sukan Tunku Mahkota Ismail (SSTMI) aged from 16 to 18 years participated in this study. Subjects were randomly divided into three groups, which are the treatment, manual and control group with each group consisting of 30 subjects. Five Malaysian rugby coaches were selected to evaluate the validity of the developed device. The "Simultaneous Ball Throw Out of Both Hands" test was used to assess the hand-eye coordination of the players before and after the intervention was carried out. During the intervention stage each group received a different form of training for two weeks; the treatment group used the KIHECT device, the manual group used the conventional approach to train the accuracy of hand-eye coordination and the control group were involved in routine training with the coach. Three types of statistical analysis were applied to analyze the data obtained, which included the test-retest, paired sample t-test and one-way Anova test. The test-retest gave a reliability value higher than 0.6. In the paired sample t-test, the result was significantly different ($p<0.05$) for the treatment and manual group to compare the effectiveness of the training methods used by each group. The One-Way Anova test, there was no significant difference between the treatment and manual group. However, there were significant differences for comparison between the treatment and control group as well as the manual and control group. This showed that the KIHECT device is beneficial as a medium to maximize the accuracy of hand-eye coordination, and it is seen to have potential in applications of sports technology.

ABSTRAK

Alat *Kinect Hand-Eye Coordination Technology* (KIHECT) telah berjaya dibangunkan sebagai alat rehabilitasi untuk meningkatkan ketepatan kemahiran koordinasi tangan dan mata (HEC) di kalangan pemain junior ragbi Malaysia. Seramai Sembilan puluh subjek dari kalangan pemain ragbi Sekolah Sukan Tunku Mahkota Ismail (SSTMI) yang berumur 16 hingga 18 tahun telah mengambil bahagian. Subjek dibahagikan secara rawak kepada tiga kumpulan, iaitu kumpulan rawatan, manual dan kawalan yang terdiri daripada 30 subjek setiap kumpulan. Lima jurulatih ragbi Malaysia telah dipilih untuk menilai kesahan alat yang dibangunkan. Ujian "Lontaran Bola Serentak Menggunakan Kedua Belah Tangan" digunakan untuk menguji kemahiran koordinasi tangan dan mata pemain sebelum dan selepas intervensi dilaksanakan. Di peringkat intervensi, setiap kumpulan telah menerima jenis latihan yang berbeza selama dua minggu; kumpulan rawatan telah menggunakan alat KIHECT yang dibangunkan, kumpulan manual menggunakan kaedah konvensional untuk melatih ketepatan kemahiran koordinasi tangan dan mata, dan kumpulan kawalan telah menjalankan latihan rutin bersama jurulatih di padang ragbi. Tiga analisis statistik telah digunakan di dalam kajian ini iaitu uji-ulang uji, ujian-T, dan ujian Anova sehala. Keputusan uji-ulang uji menunjukkan kebolehpercayaan adalah lebih tinggi daripada nilai 0.6. Keputusan ujian-t mendapati terdapat perbezaan yang signifikan ($p<0.05$) bagi kumpulan rawatan dan kumpulan manual. Bagi ujian Anova sehala, perbandingan antara kumpulan rawatan dan kumpulan manual menunjukkan tidak terdapat perbezaaan yang signifikan. Walaubagaimanapun, terdapat perbezaan yang signifikan bagi perbandingan antara kumpulan rawatan dan kawalan serta kumpulan manual dan kawalan. Ini menunjukkan bahawa alat KIHECT adalah kaedah berkesan untuk melatih kemahiran HEC kepada pemain pelapis ragbi Malaysia. Alat KIHECT adalah bermanfaat sebagai medium untuk memaksimumkan kemahiran ketepatan koordinasi tangan dan mata, dan ia dilihat mempunyai potensi tinggi dalam aplikasi teknologi sukan.

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BEC	-	body-eye coordination
CPA	-	central-peripheral awareness (CPA)
Df	-	degree of freedom
F	-	frequency
HEC	-	hand-eye coordination
HSD	-	Honest Significance Different
ISD	-	Instrument System Design
KIHECT	-	Kinect Hand-Eye Coordination Technology
M	-	mean
MRU	-	Malaysia Rugby Union
N	-	number of subjects (players)
SD	-	standard deviation
Sig.	-	level of significance
SPSS	-	Statistical Package Social Science
SSTMI	-	Sekolah Sukan Tunku Mahkota Ismail
SVA	-	Snellen Visual Acuity
VC	-	visual concentration
VRT	-	visual response time

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Rugby union has become a general and popular sport throughout the world. It is known by more than 100 countries worldwide and played from primary school level to postgraduate level (Marnewick, 2008). According to the Rugby Football Union (2011), rugby is a famous sport among men, women, and children in 100 countries across the five continents. It could be seen from the addition of the Rugby Sevens to the Olympics in Rio de Janeiro 2016 (International Rugby Board, 2016).

Ludeke (2010) agreed with Winder (1991a) that is rugby as a competitive and physical-contact sport that creates excitement and needs physical and emotional commitment to the game. As a matter of fact, most people played rugby as recreational activity to gain motor skills enhancement and physical fitness. It is related to a variety of skills according to physical differences, gender, and age to get involved in a normal environment (Marnewick, 2008; International Rugby Board, 2007).

According to Calder (1999), the visual skills and sport-specific skills can be enhanced substantially with the training of vision and specific visual awareness. Thus, the research by Ferreira (2001) agreed with Calder (2002) whereby the visual skills

such as hand-eye coordination (HEC), body-eye coordination (BEC), visual reaction speed or response time (VRT), central-peripheral awareness (CPA), and visual concentration (VC) are very important which play a large role when playing rugby. This is parallel with Erickson (2007) and Vickers (2007) that those skills are the four vital and critical performance factors in sports. However, the current research focuses on one component which is the hand-eye coordination (HEC). The purpose of the research is to develop a device known as Kinect Hand-Eye Coordination Technology (KIHECT) that is used to improve the accuracy of HEC in rugby performance.

The research by Smart (2011) stated that the performance of the motor skills cannot be enhanced if the players only focused on their physical nature. It means that the genetic factor does not promise the best performance of the players and the specific training is the best way to improve their performance. Bramley (2006) mentioned that physical attributes, such as speed, contributes greatly in modern sport such as rugby.

Particularly, the physical characteristics are essential to be productive in rugby performance, especially in determining the role of the specific position within competition. While, the physical fitness are important in rugby sports such as agility, balance, speed, power, coordination and reaction time. Unfortunately, those components are meaningless in the rugby performance without the visual skills. According to Calder (1999), the visual skills and sport-specific skills substantially can be enhanced with the training of visual and specific visual awareness.

1.2 Background of Study

Visual skills stand out as the crucial skills needed by rugby players and play a big role in rugby (Ferreira, 2001). Abernethy (1986) divides the visual system into two components which are software skill and hardware skill. Software skill represents the

cognitive differences in the analysis, selection, coding, and general handling of visual information, whereas the physical differences in the mechanical and optometric properties of the visual system are referred as hardware skills (Abernethy, 1987). This is explained by Ferreira (2002) in which the software skill comprises hand-eye coordination (HEC), body-eye coordination (BEC), central-peripheral awareness (CPA), visual response time (VRT), and visual concentration (VC), while hardware skill comprises static acuity, contrast sensitivity, accommodation flexibility, fusion flexibility, stereopsis, and colour vision. These components are important for rugby players during the tournament.

According to Ludeke (2010), the ability of each rugby player to perform in a certain number of individual skills such as catching, kicking, running, tackling, ball handling while running, having the body on the ground, and maintaining possession of the ball is necessary. This means that the visual skills and individual skills are related in which both are vital during training, testing, or in a game situation.

According to Jamara *et al.,* (2008), the visual skills (or also known as vision), include the training and testing of the hand-eye coordination, response time, peripheral vision, visual attention, and anticipation in combination with top training regimes. Unfortunately, according to Hafifi (2015) as coach for Malaysian junior rugby team, a lot of conventional training have been used rather than using technology to improve the accuracy of HEC in rugby. The conventional method that have been used to enhance the HEC is the object manipulation. The examples of HEC test and training for object manipulation are turn and catch, push up to catch, step test and passing for accuracy (Du Toit *et al*., 2012a), alternate hand toss-modified simultaneous ball throw (Bloomfield *et al.*, 1994), and simultaneous ball throw out of both hands (Du Toit *et al.,* 2007a).

Nowadays, the use of sophisticated technological as assisting tool is important to enhance athletes' performance. Unfortunately, there is still not much involvement

from the technology aspect to improve the training of the HEC. Research by James and Will (2015) revealed that the combination of technology and sport science in training situations of professional and amateur athletes have become progressively popular within the last few years. This is supported by Fu (2013) who states that to improvise the teaching and learning process, it is compulsory to have a vital objective of technology integrations

1.3 Problem Statements

There are two problems faced by Malaysian junior rugby players that have been identified in this research. Firstly, the lack of accuracy in HEC is the main factor that affects the athletes' performance during the tournament/training. This is supported by the coach of Malaysian junior rugby team, Hafifi (2015) stated that the weakness or slow accuracy of HEC commonly occurred in game situations, especially during catching and passing activities, leads to the silly mistakes made by the players, such as "knock on" and lost ball possession. Du Toit *et al.,* (2007a) explained that if the signals given by the eyes to the brain is incorrect, their inability to focus clearly would affect them negatively and will lower their performance due to the disability of their sensory (eyes) to change focus quickly and disability of the visual information to be processed swiftly.

According to Gonzalez *et al.,* (2011), the accuracy of HEC is important to detect the movement of the hands with the eyes, hence, enabling the eyes to send the compulsory signals of the hand movement to the brain. Therefore, poor accuracy of HEC can greatly weaken the ability to exercise or even move, which may also affect the everyday basic tasks, such as writing. According to Du Toit *et al.* (2010), the ability of athletes are fully dependent on their accuracy of HEC.

For instance, Ludeke (2010) stated that, in rugby sport, the jumper should be more focus using their eyes and hands to catch the ball from the passer during lineout situations. The HEC is connected with reaction during the catching activities, as supported by Buys (2002), which examined the ability of athletes on how they react effectively to the stimuli involving the hand-eye action.

Another example for ability dependency on the accuracy of HEC was explained by Crawford *et al.,* (2004) where during activities of receiving (or catching) a ball, the player needs to keep his chin up and eyes open. In other words, to ensure that the speed consistent and to extend his arms in the way the ball is coming from, the receiver should be in the correct depth position. It is easier for the passer to identify the target (receiver), and then the receiver will be more focus to catch the ball nicely and accurately using his eyes.

In addition, Ludeke (2010) emphasized that the ability of individual skills needed by the players are running, kicking, catching, tackling, handling the ball with both hands while speeding (or running) on the pitch (or field), and provisionally sustaining the position of body into contact. Hence, according to Williams *et al.,* (1999), the movement of the athletes, ball, and many more can affect their performance if they are lacking in the accuracy of HEC.

Based on previous study by Tomporowski and Ellis (1986), they found that the short-term exercises are not effective for the athletes' accuracy of HEC. That means the long-term exercises (or repeated training) are required to improve the accuracy of HEC. Ludeke (2010) claimed that the athletes need 500 hours of training (a long period of time) for convertible existing ability to be used in a tournament.

Stefanie (2008) pointed out that the poor accuracy of HEC could affect an athlete's performance and potential if his/her visual system do not function optimally.

Therefore, the compulsory factor to be excellent in sports is the visual skills performance, whereby the poor visual skills will impede performance in most sport activities. As a result, it could even cause the team defeat/loss in a tournament. Besides that, Vuuren *et al.,* (2006) said that the poor visual skills are caused by the deterioration of the visual skills and coordination, emotional or psychological stress, hydration status and lack of nutrition, decrease in exercises or fitness level, and lack of sleep. As Calder (2002) asserts, the accuracy of HEC is one of the most crucial aspect needed in sport, specifically in rugby.

The second problem faced by Malaysian junior rugby players is the lack of technology in the form of instruments to correct and improve their accuracy of HEC. According to Jude (2015) who is the Malaysian junior rugby's coach, states that there are a lot of conventional training that can be applied to improve the accuracy of HEC specifically for rugby, for examples, the alternate hand-toss-modified simultaneous ball throw (Bloomfield *et al.*, 1994), and simultaneous ball throw out of both hands (Du Toit *et al.*, 2007a). While, Hafifi (2015) said the use of upgraded technology will be more effective in sports training, especially to test the ability of athletes and to improve their performance in rugby.

In reality, based on research, the use of sports technology will be more effective as compared to the use of conventional methods mentioned in the previous section. According to Becker *et al.*, (2015), the combination of technology and sport science in training situations for professional and amateur athletes have become progressively popular within these few years. Meanwhile, Fu (2013) recommended improvising the teaching and learning process through the integration of technology.

According to previous researches, the researchers developed a new technology which is called as Kinect Hand-Eye Coordination Technology (KIHECT). KIHECT device is developed and upgraded from the previous device, which is Kinect, to function as a rehabilitation tool to improve the accuracy of HEC. The development of

KIHECT device involves the combination of software and hardware technology that are capable to improve the accuracy of HEC. According to Wirth (2003), the hardware and software co-design become to be a trendy development in this research area. The researcher also proposes to implement the calibration protocols for reliability and validity tests onto KIHECT device.

1.4 Research Objectives

This research is carried out to develop the Kinect Hand-Eye Coordination Technology (KIHECT) as a rehabilitation tool to improve the accuracy of hand-eye coordination (HEC) among Malaysian rugby juniors. The objectives of this research are outlined as follows:

(i) To measure and compare the accuracy of HEC among Malaysian junior rugby players between the treatment, manual, and control group in the "Simultaneous Ball Throw Out of Both Hands" pre-test.

(ii) To develop KIHECT device as a rehabilitation tool in improving the accuracy of HEC among Malaysian junior rugby players.

(iii) To compare the different approaches (using KIHECT device, Alternate Hand-Wall Toss, and common training) to improve the accuracy of HEC among the Malaysian junior rugby players.

(iv) To measure and compare the accuracy of HEC among Malaysian junior rugby players between the treatment, manual, and control group in the "Simultaneous Ball Throw Out of Both Hands" post-test.

1.5 Research Questions

The purpose of this study is to develop the KIHECT device. The study is concerned with the following research questions:

(i) What are the measurement and comparison in the accuracy of HEC among Malaysian junior rugby players between the treatment, manual, and control group in the "Simultaneous Ball Throw Out of Both Hands" pre-test?

(ii) What are the reliability and validity of KIHECT device as a rehabilitation tool in improving the accuracy of HEC among Malaysian junior rugby players?

(iii) Which is the most effective approaches (between KIHECT device, Alternate Hand-Wall Toss, and common training) to improve the accuracy of HEC among Malaysian junior rugby player?

(iv) What are the measurement and comparison in the accuracy of HEC among Malaysian junior rugby players between the treatment, manual, and control group in the "Simultaneous Ball Throw Out of Both Hands" post-test?

1.6 Theoretical Framework

The theoretical framework is a diagram that chains the theories in developing the intervention instrument. It could be an excellent guide in the research to determine what is measurable. To support the case study of the weakness in accuracy of HEC among the Malaysian junior rugby players which are commonly occurred in game situations, thus, the KIHECT device is developed to improve their accuracy of HEC. Therefore, two theories have been employed, as illustrated in Figure 1.1, which are the Motor Learning Theory and Cognitive Theory.

1.7 Conceptual Framework

The conceptual framework is developed and used in this research to outline possible courses to present a preferred approach to an idea or thought. Furthermore, it helps the researcher to implement the research easily without any problem. In the conceptual framework as shown in Figure 1.2, the instrument that could be used to overcome the problems outlined in the problem statements has been identified, which is KIHECT device. It integrates the HEC in rugby with previous technology and conventional tests.

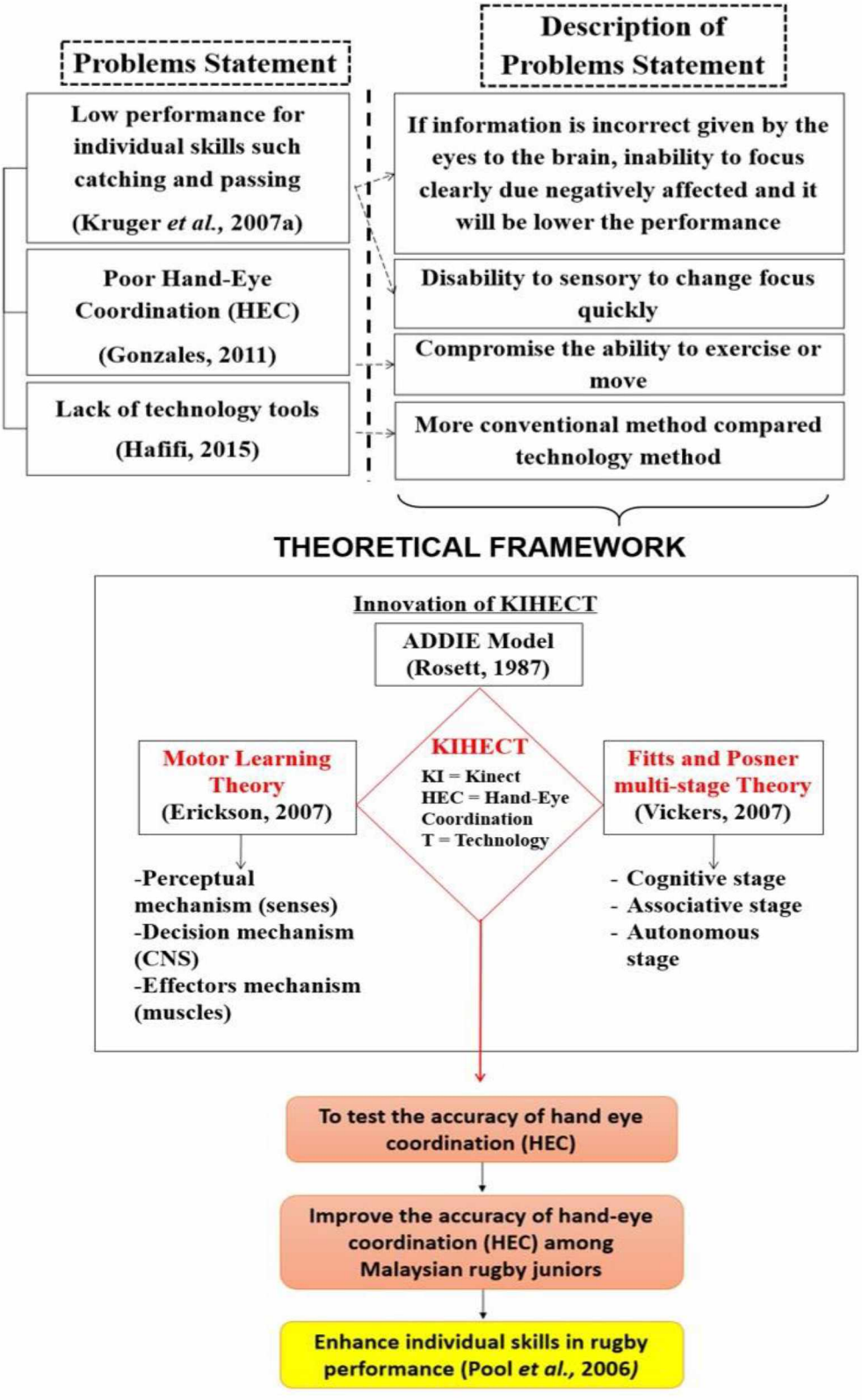

Figure 1.1 Theoretical framework

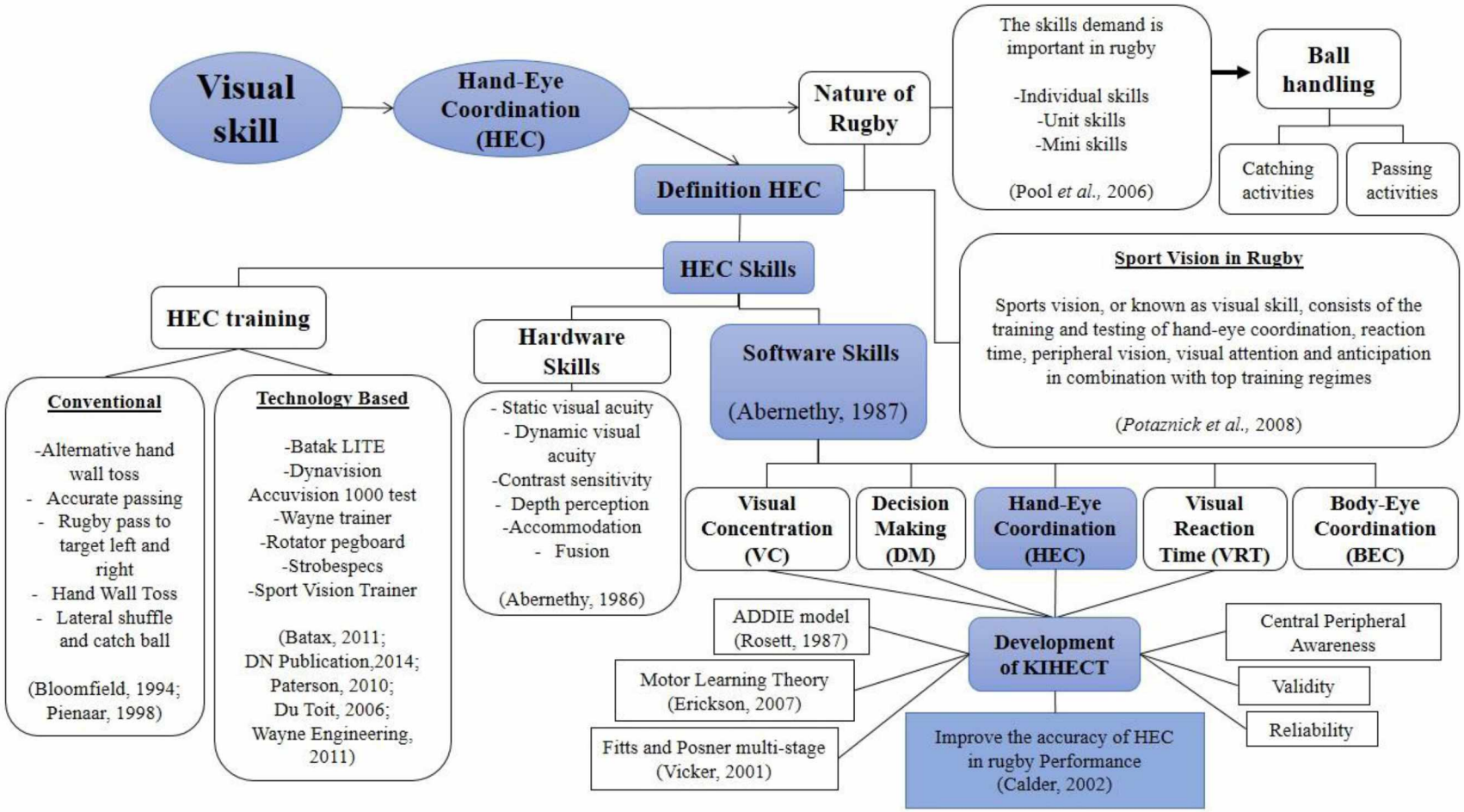

Figure 1.2: Conceptual framework

1.8 Significance of Study

This study is carried out due to several reasons. It is expected to be beneficial to the researchers as it will provide better understanding and informations on the KIHECT device fundamentally. Furthermore, the KIHECT device is expected to be advantageous and useful for athletes (or players) and coaches. The validity of KIHECT device on the athletes' performance is very high because it provides a specific training, especially for accuracy of HEC. The device is affordable for any institutions, including Malaysia Rugby Union (MRU), National Sport Council (MSN), sports centre/school and so on. The advantages of the KIHECT device for athlete (or player) and coach are explained as follows:

1.8.1 Athlete

This research is important to help the hand movements of Malaysian junior rugby players in order to improve their accuracy of HEC. Based on previous studies, the importance of hand-eye coordination (HEC), body-eye coordination (BEC), central peripheral awareness (CPA), visual concentration (VC), and visual response time (VRT) which are categorized as the software components of the visual skills have become specialized in the rugby game (Tomporowski, 2003). Furthermore, training is required in developing their skill performance. Hence, this technology tool can be used to train the movement of individual skills to be improved optimally.

Thus, these components of visual skills play a major role and are compulsory in rugby performance. As Stewart (1987) explained, the visual skills are related with the ball handling, tackling, catching, kicking, and running. Besides that, Ludeke (2010) is in accordance with Sosniak (1985), that the age of 18 years and above is the best

performance phase age range for players to have almost optimum ability as far as physical and skill capacities are concerned.

The KIHECT device can be used not only in sports institutions, but it also can be used at home. The device is important and beneficial to athletes, specifically rugby players, because it helps athletes to train and measure the level of their visual skills, specifically the accuracy of HEC, by improving the skills performance in catching activity through a high level of coordination with vision in the sports.

The KIHECT device operates when each stimuli touch of the hands movement, it will count as one point either fast or slow depending on the athletes' accuracy of HEC. Technically, for about 8-12 years (or 10,000 hours) of training) are required to achieve the elite level as a professional players (Ericsson and Charness, 1994; Ericsson *et al.*, 1993; Sosniak, 1985). Meanwhile, according to Ludeke (2010), it needs 500 hours of training for convertible existing proficiency in order to use that skill in a tournament. It means, the long period of training are required to have an improved ability to be performed in the game situations.

1.8.2 Coach

The KIHECT device employs the concept of a virtual coach for the virtual product which does not engage to any physical contact with the product. This product is essential and should be used especially for athletes and coaches as it has been proven the athletes' concentration and accuracy of HEC can be directly improved (Du Toit *et al.*, 2010). It is found that the ability of players is fully dependent on their ability in accuracy of HEC. As mentioned before, most of the coaches, specifically in Malaysia, use the conventional method rather than adopt the newer technology and invention instruments in training. The employment of KIHECT device would help the coaches

to conduct the training easily for a more effective learning and training on athletes. Thus, this research will contribute to the rugby sports, specifically to help the players to improve their visual skills by using KIHECT device.

1.9 Scope of Study

KIHECT device is developed by using fewer raw materials as components (such as steel, plastic, rubber, and so on) with the combination of the software and hardware technology (which are Kinect SDK window and Kinect 3D camera device, respectively). Even though the KIHECT device is capable to train, correct and improve the athletes' accuracy of HEC, however, the KIHECT device has limitations whereby it has been programmed to one component of the software visual skill only, which is the accuracy of HEC to enhance the ability in catching activities. It is recommended to extend to other components of visual skills. According to Loran and MacEwan, (1995), the accuracy of HEC could be improved by implementing various training techniques that could be learnt by the athletes. This research was carried out among the Malaysian junior rugby players in Sekolah Sukan Tunku Mahkota Ismail (SSTMI) at Bandar Penawar, Kota Tinggi, Johor. There are 90 rugby players participated as subjects for this research in order to identify the reliability and validity of the KIHECT device as a medium in improving the accuracy of HEC in ball catching and passing activity in rugby.

1.10 Conclusion

Chapter 1 outlines the characteristics of the sport performance, specifically in HEC, and the importance of visual skills in rugby games. The accuracy of HEC plays a crucial role and could influence the athletes' performance during a tournament. In this chapter also, the research guidelines have been briefly explained, such as the theoretical framework. Besides that, this chapter highlights the use of KIHECT device which is the latest technology in sport performance as a medium to enhance the athletes' accuracy of HEC.

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