A Framework for the Integration of Mobile Technology into Adventure Sport for the Purpose of Increasing Participant Safety

by

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Research Project Proposal

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Supervisor: Dr B.P. Haskins

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Declaration

I, *Craig John Mills, Student Number 215368827*, hereby declare that the *dissertation* for *Master Information Technology* is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

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UNIVERSITY

DECLARATION BY CANDIDATE

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QUALIFICATION: Master of information technology (MIT)

TITLE OF PROJECT: A framework for the integration of mobile technology into an adventure sport for the purpose of increasing participant safety.

DECLARATION:

In accordance with Rule G5.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: _____

DATE: 26/07/2018

Abstract

The sporting industry has seen incredible advancements with the use of information technology. Technology is used in the sporting industry for training, coaching and even as a deciding factor of a game result. There are certain sports which require individuals to venture into isolated environments, these sports have been termed adventure or extreme sports. Due to the extreme environmental factors that can occur with adventure sport, it is possible for an individual to experience an emergency situation.

Emergency situations can occur at any time, and this is especially true in adventure sport. Adventure sport such as ocean and river kayaking require individuals to venture into isolated environments, where if an emergency situation occurs could result in an individual left stranded waiting for emergency rescue. Adventure sport participants and Event Organizers are aware of the dangers associated with this type of adventure sport, but there is currently no requirement to have a mobile technology device present during kayaking events.

The main purpose of this dissertation was to evaluate the current use of mobile technology in adventure sport in the Eastern Cape province of South Africa. To accomplish this two literature reviews were conducted which identified information on the two main themes which are adventure sport and mobile technology. To produce information from the ocean and river kayaking community an online questionnaire was distributed to several kayaking clubs in the Eastern Cape province of South Africa.

This dissertation also presents a framework that proposes the use of mobile technology hardware and software by participants and event organisers in an attempt to increase the safety of events in this form of adventure sport.

It is hoped that the framework for using mobile technology to increase the safety of adventure sport proposed in this research, may provide clear guidance for the achievement of a safer sporting experience for the participants of ocean and river kayaking.

Acknowledgements

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List of Abbreviations

AEP	Adventure Experience Paradigm
API	Application Programming Interface
ASP	Active Server Pages
CSA	Canoeing South Africa
CSS	Cascading Style Sheets
DRD4	Dopamine Receptor D4
ESPN	Extreme Sport Network
LTE	Long Term Evolution
GPS	Global Positioning System
GPRS	General Packet Radio System
GSM	Groupe Special Mobile
GWE	Graphics Window Event
HTML	Hyper Text Markup Language
MBPS	Megabits per second
MVNO	Mobile virtual operator
NSRI	National Sea Rescue Institute
OHA	Open Handset Alliance
OS	Operating System
PDCA	Plan Do Check Act
PDA	Personal Digital Assistant
PLB	Personal Locator Beacon
RFID	Radio-Frequency Identification Devices
RIM	Research in Motion
SAMSA	South African Marine Authority
SDK	Software Development Kit
SMS	Short Message Service

SPOT	Satellite Personal Tracker
UIAA	International Mountaineering and Climbing Federation
USSD	Unstructured Supplementary Service Data
VM	Virtual Machine

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Chapter 1

Introduction

Information technology can reduce the rate of errors in three ways: by preventing errors and adverse events, by facilitating a more rapid response after an adverse event has occurred, and by tracking and providing feedback about adverse events.(Orlikowski, 2000)
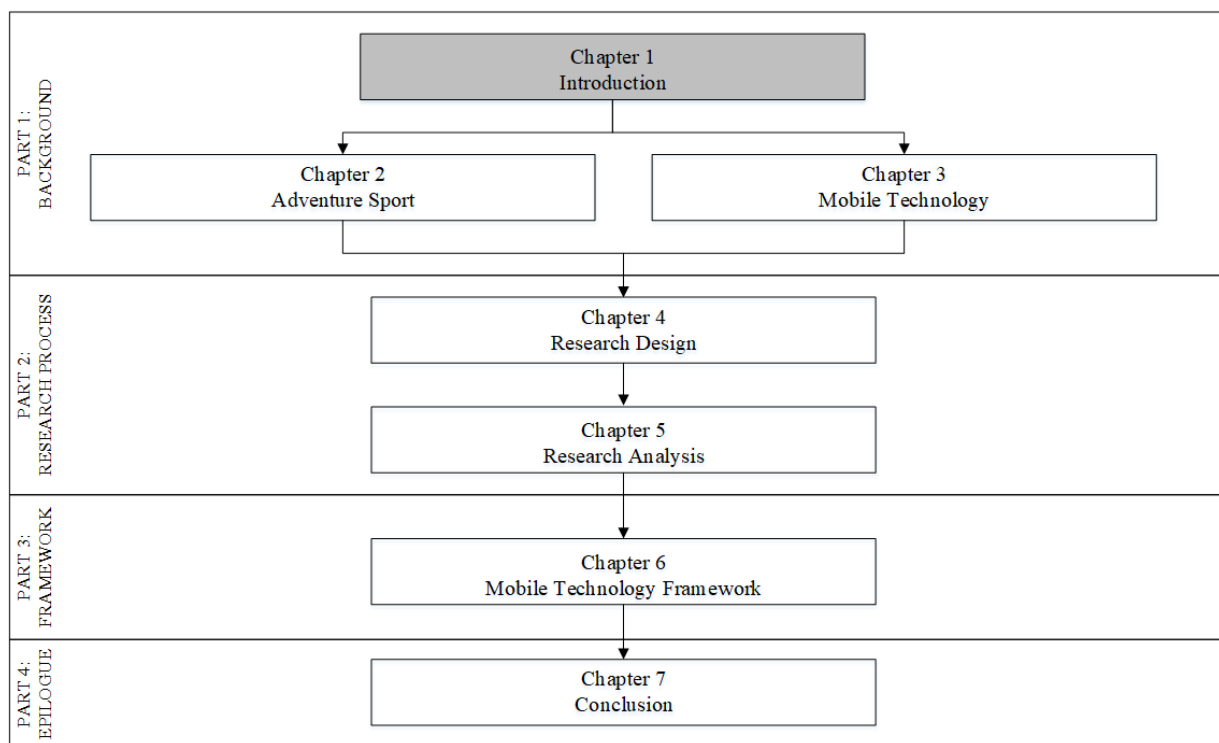
1.1 Background

In today's sporting industry, technology is seamlessly integrated into all types of sporting activities. It would be difficult to imagine a sporting event where technology does not play an important role. To appreciate how far technology and sport have evolved Fridell (2008) states that the best technology used in sport before computers were invented was the stopwatch. Technology not only assists in sporting decisions, but assists with training and coaching and can be used to assist in the safety of certain types of sports that are dangerous in nature.

The sporting industry has seen the rise of a new type of sporting culture that provides athletes with a sense of adventure and adrenaline, but has associated risk and danger. These sports have become known as adventure or extreme sport and have gained popularity in participation and spectator viewing. According to Wheaton (2004, p. 2), academic literature has examined a phenomena of the sporting industry often termed extreme, action or postmodern. The focus of this study is on the integration of mobile technology into adventure sport for the purpose of increasing participant safety.

The following discussion explores the research topic in more detail by providing information needed to understand the concept.

1.1.1 Adventure Sport

Unlike traditional sport, which take place in controlled sporting environments, adventure sport require an individual to battle environmental variables as well as other participants. Environmental variables include weather changes such as increased waves, wind, snow and extreme hot and cold conditions which could place an individuals life in danger. McNamee (2007, p. 82) states that, due to the remoteness in which adventure sport typically takes place, there are often factors that participants cannot control, therefore making it impossible to remove risks from this type of sport.

The risks and dangers involved in adventure sport are not always obvious, resulting in adventure sport organizers requiring athletes to sign indemnity forms before participating in an event. The dangers, risks and remote locations involved in these type of sport magnify the adrenaline rush and create an emotional excitement allowing an adventure seeker to escape from everyday life.

Over the past few years adventure sport has become increasingly popular in South Africa, which include ocean and river kayaking, cross country marathons, back-packing, surfing, hiking, deep sea and river fishing, bush walking and 4x4 enthusiasts to mention a few. Adventure sport exposes an individual to the natural beauty of our country but often require individual's to venture into areas where there is little or no human contact. South

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Africa offers 3 000 kilometres of coastline along with breathtaking mountains often side by side. The country's diverse terrain, together with an ideal climate for outdoor activities, make it a rich hunting ground for adrenaline seekers (SouthAfrica.Info, 2015).

Emergency situations do occur in adventure sport resulting in individuals being stranded in isolated environments, waiting for rescue workers to locate and perform rescue operations. In response to the safety concerns, industry has created a wide range of commercial paraphernalia and state of the art mobile technology in an attempt to increase the safety of adventure sport. It is imperative that the sporting industry use mobile technology to provide accurate information for decision making in rescue operations. As stated by Gething and Tatem (2011) disaster management requires accurate information and must link data collection and analysis to an immediate decision-making process.

1.1.2   Mobile Technology

Mobile technology has influenced the way people work and interact with one another. The demand for mobile and wireless technology has resulted in devices that have advanced features which increase productivity and customer satisfaction. Mobile technology has broken geographical boundaries and allowed humans to live a life style of geographical reach. Kakihara and Sorensen (2002, p.6) postulates that individuals who make use of mobile technology, will be in a position to live and travel where they desire and will have to decide whether they are settlers or global nomads.

The nomadic nature of human beings allow mobile technology devices to travel with individuals by aircraft, boat, car or even foot. The concept of mobility does not only refer to the ability of people to travel but includes the ability for anywhere, any time communication. The demand for mobile devices is due to the features and abilities the device's provide. The amount of mobile phone users in Africa alone has grown immensely. In 1999, only 10 percent of the African population had mobile phone coverage, primarily in North and South Africa. According to Aker and Mbiti (2010, p.4) by 2008 sixty percent of the African population were making use of mobile phones, in an area of 11.2 million square kilometers.

The adoption of mobile technology in industry and society is occurring at a fast rate, which can also be observed in the sporting industry. Mobile technology for sporting events is gaining popularity due to convenience and configuration ability the mobile devices possess. Today, the sporting industry is extremely competitive and requires the right type of technology to provide accurate information on training and performance. Integrating mobile technology into sport allow coaches and athletes to obtain real time information on fitness levels, speed and performance improvement. According to Taylor, Abdulla, Helmer,

Lee, and Blanchonette (2011) mobile technology applications that currently exist for sport training must be started at the commencement of a training session and stopped at completion and record the same data throughout a training session. Mobile technology does not only provide an athlete with valuable information for competitive advantage but also provide a method to improve the safety of adventure sport taking place in remote locations.

1.2   Problem Statement

The associated risks involved in adventure sport are often not realized until an emergency situation occurs. Isaksen (2012) confirms this by stating that adventure sport activities go against our natural human instincts, which are designed to protect us. Adventure sport often takes place in areas not known to rescue workers. When emergency situations occur an individual could be left stranded in an isolated environment, waiting for rescue workers to locate their position. During an emergency situation rescue workers do not have time to evaluate physical maps to determine the possible location of the missing adventurer. These situations are often stressful and require timely and accurate geographical data to pin point the exact location of the individual in distress.

The main problem addressed in this study is that no structured framework currently exists within South Africa for integrating mobile technology into adventure sport for the purpose of increasing participant safety.

1.3   Research Questions

The following research questions have been identified to assist in the development of a framework for this study. The primary research question is:

How can mobile technology be integrated into adventure sport from a South African context, to assist in the safety of participants during event?

The following secondary research questions have been formulated in support of the primary research question:

1. What is the willingness of adventure sport participants to use mobile technology in their events?

2. What mobile technology factors may adversely affect search and rescue operations of stranded adventure sport participants during events?

3. What identified concepts and components could be incorporated into a mobile technology framework, to minimize the communication gap between participants and emergency response teams?

1.4   Research Objectives

To support the identified research questions in this study, the following primary research objective has been articulated:

To formulate a framework for the integration of mobile technology into adventure sport to improve participant safety during events, within the context of South Africa.

The secondary research objectives in this study will include:

1. Identify the willingness of the participants to use mobile technology in adventure sporting events.

2. Identify the mobile technology factors that may adversely affect the search and rescue operations of stranded adventure sport participants during events.

3. Establish which concepts and components can be incorporated into a mobile technology framework, to minimize the communication gap between participants and emergency response teams.

1.5   Scope and Delineation

Most aspects of adventure sport is applicable world-wide, but for the purpose of this study the focus was on ocean and river kayaking in the Eastern Cape province of South Africa. Although it would have been helpful to explore the safety issues pertinent to all adventure sport in South Africa this could not be explored as to complete the study within the allocated time-line.

The formulation of a framework was done which relied upon the findings of two literature reviews and the results obtained from an online questionnaire. The proposed framework in this study focused on four aspects namely the Human Element, Hardware, Software and the Events that the participants take part in. The framework proposed in this study is only conceptual and has not been applied or tested in a real-world situation.

Therefore the development of a mobile technology application prototype did not form part of this dissertation.

1.6   Ethical Considerations

Ethical clearance was requested from Nelson Mandela Metropolitan University with regards to the online questionnaire. All the participants were over the age of 18 and completed the questionnaire anonymously, therefore no formal ethical clearance was required.

1.7   Chapter Layout

The following is a proposed chapter layout including a brief description of each chapter. The layout of the proposed study is depicted in figure 1.1.

Chapter 1 of this study serves as the introductory chapter which includes the background information, problem statement, research questions and objectives. Chapter 2 deals with a literature review on adventure sport. The various types of adventure sports are discussed as well as the current safety standards that pertain to this type of sport. Chapter 3 continues the literature review focusing on mobile technology currently used in adventure sport. Chapter 4 covers the selected research methodology and design used to achieve the objectives in the study.

Chapter 5 is an analysis of the conducted research to identify the concepts and components that could be incorporated into a framework to assist in the safety of adventure sport. Chapter 6 presents a proposed mobile technology framework based on the concepts and components identified in the previous chapters. Chapter 7 concludes the study and revisits Chapter 1 to ensure that the research objectives have been met. Suggested future avenues of research are also mentioned.
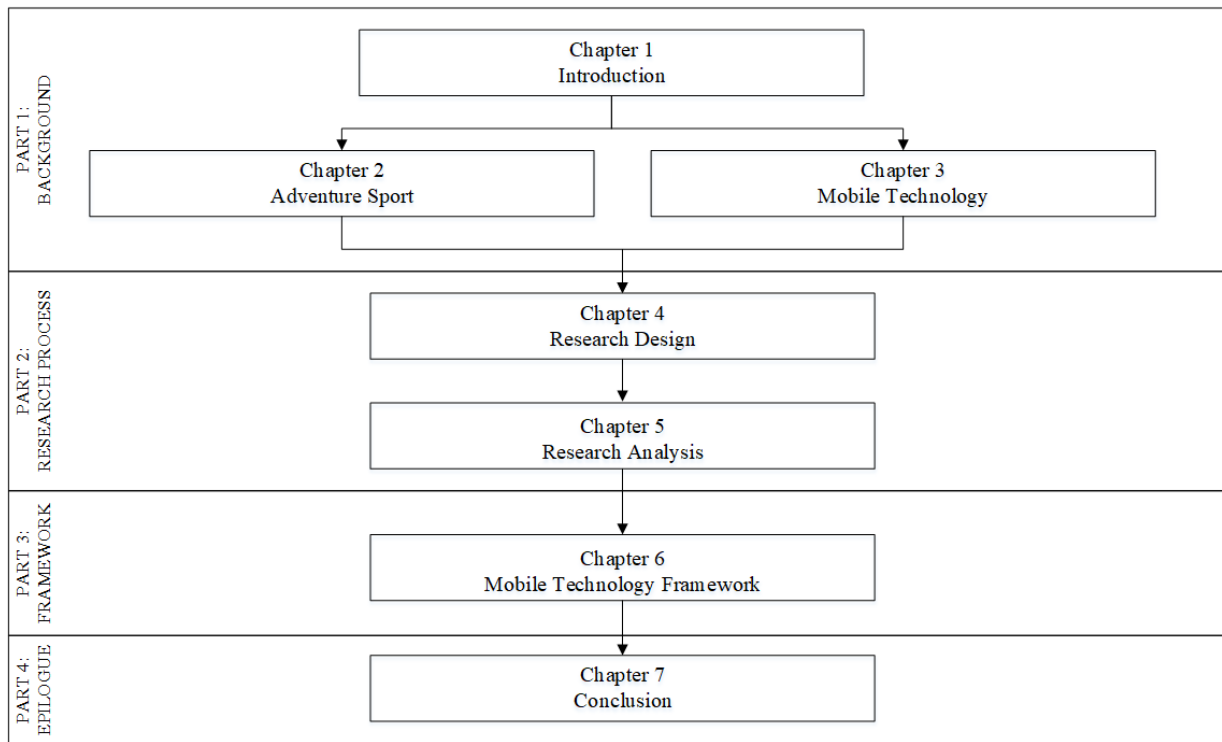
Figure 1.1: Dissertation Layout

Chapter 2

Adventure Sport

These activities involve putting oneself against the elements of one's environment, whether natural or architectural.(Laviolette et al., 2008)
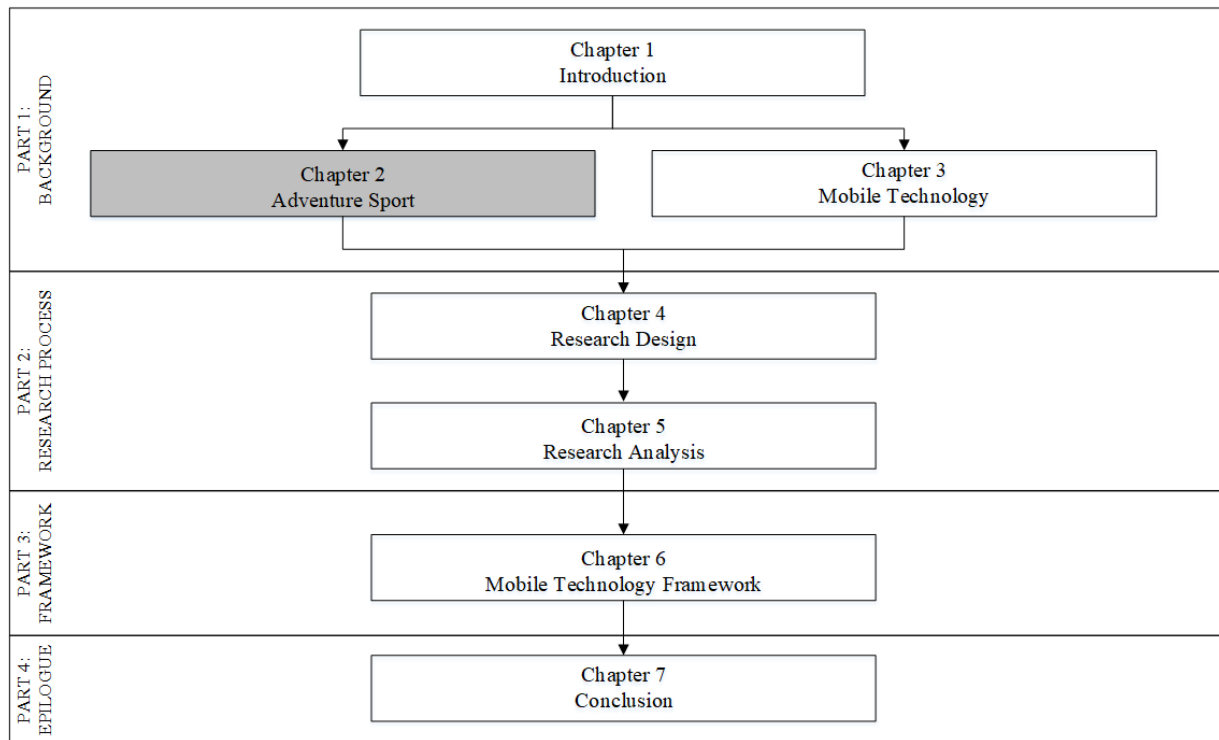
2.1 Introduction

Adventure sport, also known as extreme, risk or nature sport is a term used to describe sporting activities that can be affected by the environment's most menacing factors, and include high levels of physical activity by the participants. Adventure sport forms part of a modern society, and cannot be compared to traditional sport which have strict rules and clearly defined environments and boundaries. The Extreme-Sport (2016) defines adventure or extreme sport as *"a sport or activity that is exciting and dangerous, for example bungee jumping, white-water rafting, or base jumping"*. Breivik (2010) states that a cultivation of risk exists with individual's who partake in adventure sport, as they are adrenaline seekers and are willing to take physical and even financial risks to obtain the sensation.

The media in countries such as the United States have commercialized adventure sport through the emergence of Extreme Sport Network (ESPN) X-Games which offer participants different environmental settings and levels of involvement from amateur to an advanced level. The commercialization of adventure sport in South Africa cannot be compared to the likes of the United States, however, rugged coastlines, roaring rivers and exquisite mountain ranges make South Africa a destination hot spot for adventure sport.

2.2 Understanding Adventure Sport

The reference to the word *"adventure"* describes the challenging and demanding environments in which these sports take place. Morgan, Moore, and Mansell (2005) elucidate that before, during and after an adventure tourism process (as depicted in Figure 2.1), risks are combined with uncertainty in the participants mind as to whether they have the skills to overcome them. The risks experienced in the adventure tourism process can be compared to the environmental factors faced in adventure sport. Kane (2010) establishes the link between sport and tourism by stating that the two concepts have become cultural practices through the generations, although with diverse understandings. Tourists to adventure destinations use these practices or sport in search of memorable adventures and adrenaline boosting experiences (Laviolette et al., 2008). Figure 2.1 does not represent the dynamic nature of an adventure sport experience but rather conveys the experiences an individual may encounter during an adventure.
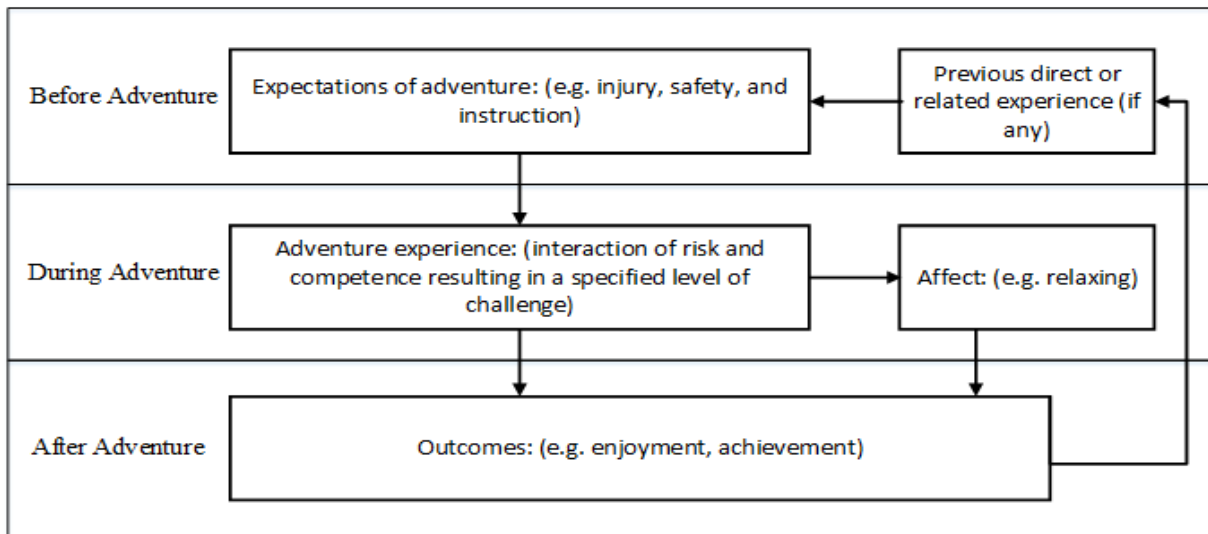
Figure 2.1: Adventure tourism framework of evaluation (before, during and after) (Morgan et al., 2005)

The skills required in adventure sport relate not only to the human body but also the ability to cope with stress and anxiety. Directly related to these factors are the perceptions of risk, prior adventure sport experience and emotional responses to the environmental factors. Breivik (2010) states that there are few circumstances where an individual could get an emotional high on the body's own chemistry of adrenaline, endorphins and catecholamines.

The adventure experience paradigm (AEP) allows for the conceptualization of adventure sport. The adventure experience paradigm is widely accepted and used in adventure education to design and manage perceived risks. The AEP was proposed by Priest and Martin (1985) consists of 5 distinct states, namely exploration and experimentation, adventure, peak adventure misadventure and lastly devastation and disaster. Figure 2.2 represents the AEP paradigm that has been used to understand adventure by society.
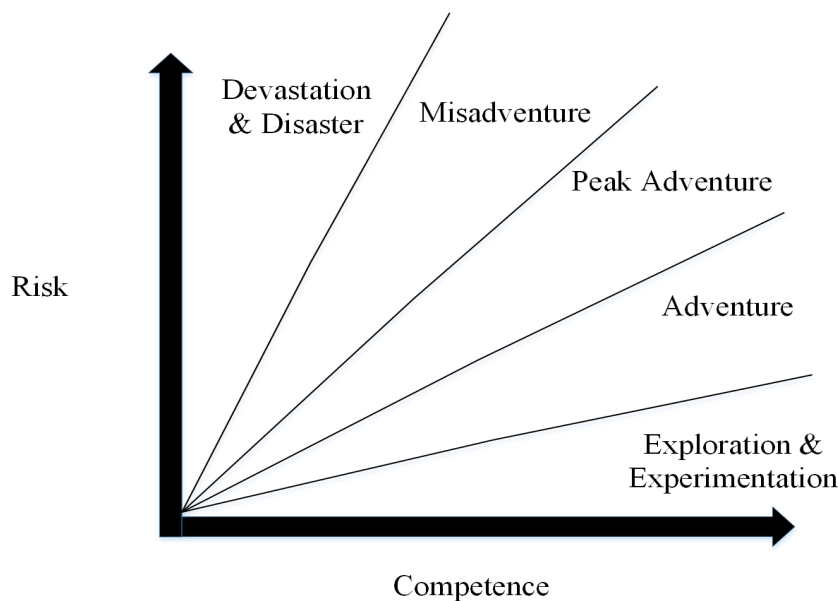
Figure 2.2: The Adventure Experience Paradigm
(Priest & Martin, 1985)

The devastation and disaster state occurs when an individual is overwhelmed by the risk and could result in severe injury or even death. When the competence of the adventurer does not quite meet the skills required to match the risk, misadventure could be experienced. The peak adventure state often requires intense concentration on behalf of the adventurer as their skill set matches the risk. The adventure state condition occurs when the risk is perceived as being lower than the competence level. Finally the exploration and experimentation condition occurs when the risk during the adventure is low and the competence level is high, which creates a more relaxed setting for the adventurer.

Regardless of the risks experienced in adventure sport, individuals are still willing to take the risk's to achieve the desired outcome or sensation. The next section explains the reasons for individuals participating in adventure sport.

2.3   Why do individuals participate in adventure sport?

There appears to be a paradox of emotions experienced by participants of adventure sport. On the one hand adventurers want safety during their sporting adventure, and on the other hand they are willing to expose themselves to danger and risk. Breivik (2010) identifies the following five reasons for the popularity of adventure sport which has been adapted for this study in Table 2.1.

Table 2.1: Reasons for the popularity of adventure sport

REASON	DESCRIPTION
Reason 1	Evolution can explain the desire for adventure sport
Reason 2	Modern society has too much safety and control
Reason 3	Cultivation of risk in adventure sport
Reason 4	Sensation of deep flow
Reason 5	High sensation seekers are drawn to adventure sport

Evolution can explain the desire for adventure sport. The human race has always been exposed to challenges and risks. The sense of adventure was evident in early humans who crossed rivers, climbed mountain ranges and braved rough seas (Breivik, 2010). Modern society is focused on safety which leads to a lack of challenges and risks in everyday life. The sense of adventure is what makes an individual want to break free of the boundaries of our controlled society and partake in adventure sport. Hutchinson (2016) confirms this by explaining that some individuals in our society have the gene Dopamine Receptor D4 (DRD4) that makes them more prone to risk and sensation seeking. As modern society progresses, individuals engage in more extreme risk taking due to a better training, equipment and technology.

Modern society has too much safety and control. Rules and regulations govern our everyday activities, to create a controlled and safe society. Laviolette et al. (2008) states that our modern society is obsessed with controlling risk. These boundaries that society create is what makes rough, dangerous and extreme sport so attractive to individuals seeking freedom and risk taking. Breivik (2010) identifies adventure sport as a vehicle for excitement in our modern society creating an experience of freedom and joy. The risks involved in adventure sport need to be balanced, weighing the reward of the risk with the potential consequences of the risk. The higher the risk the higher the reward of excitement and adrenaline rush, but on the other end of the scale the higher risk may result in higher losses and even death.

Cultivation of risk in adventure sport. Individuals who participate in adventure sport view the risk more as an opportunity to overcome a challenge, fear or obstacle. Laviolette et al. (2008) identifies the appeal to adventure or hazardous sport as an individual confronting and honing physical skills to overcome the risk and challenges. The human race encounters many risks and dangers connected with nature, violence, wars and financial crises to mention a few. Adventure sport may be a way for an individual to escape for a moment from these uncontrollable forces by introducing positive risks that an individual can handle with the right training, equipment and skill and thereby cultivating the risk.

The sensation of deep flow. The theory of deep flow relates to when an individual of adventure sport experiences mastery, joy or other strong emotions during or after the event. Deep flow can result in the addiction to the sport, where they have the ability to use their acquired skills and display their mastery of the sport. Breivik (2010) describes the flow experiences as action and awareness, immediate feedback, feeling of competence and control, and the feeling of joy.

High sensation seekers are drawn to adventure sport. Adventure sport appeals to individuals who have an extrovert type personality. (Zuckerman, 1994) found that extroverts are mentally tough and are more likely to take risks such as those involved in adventure sport. Further studies by (Breivik, 2010) identified that extroverts are more likely to take physical and financial risks than introverts in order to gain what they want. High sensation seekers will primarily be drawn to adventure sport but this is not to say that other personality types wont on occasion be drawn to the excitement and freedom experienced by this type of sport.

2.4 Types of Adventure Sport

In the past individuals who partake in adventure sport may have been viewed as being eccentric, but with the current consumer market and media exposure extreme sport has become a popular culture in modern society. The following discussion provides a list of some popular adventure sport in South Africa as mentioned by (SouthAfrica.Info, 2015) that would require participants to venture into areas where common means of transport and communication is limited.

2.4.1 Ocean and river kayaking

Kayaking involves an individual paddling a water craft called a kayak or a canoe along a surface of water. These bodies of water include the ocean, rivers, inland lakes or dams. Kayaking is different to canoeing in that the seating position of the paddler is different. Canoeing usually involves an individual to sitting or kneeling on the canoe, whereas individuals on kayaks always sit with their legs stretched out in front of them. Kayaks sleek design are used in competitive races, whereas canoes are used in recreational activities.

Ocean and river kayaking has become extremely popular in South Africa over the past few years. The popularity of the sport is evident by viewing the Canoeing South Africa (CSA) website ladder (South Africa, 2016). The CSA ladder includes among other information a paddlers unique number, name and the amount of races that they have competed in. Races of over 100 participations are not uncommon.

Each body of water has its own challenges that could put a paddlers life in danger. Ocean and river kayaking each have their own dangers associated with the sport. The ocean presents the paddler with environmental and man made variables that are out of the paddlers control. These variables were experienced by an adventurer by the name of Peter Bray who traversed the Atlantic ocean, encountering huge waves, unyielding winds, strong currents, sharks and even supertankers ("Seaworthy", 2001). There are ever present involved in river kayaking as well which include strong currents, flash floods, rocks on the river bed and debris creating hazards.

2.4.2 Mountaineering

Mountaineering or Alpinism is the sport of climbing in the mountains with an end goal of reaching the highest point or summit of the mountain. Other forms of mountaineering include mountain hiking or rock climbing. Smith (2015) defines this adventure sport as *"the sport of attaining, or attempting to attain, high points in mountainous regions, which is a dangerous pastime for untrained individuals."* In an effort to improve safety the mountaineering community is governed by the UIAA (The international mountaineering and climbing federation) which provides recommendations on safety, medical issues and policies (Schöffl, Morrison, Hefti, Ullrich, & Küpper, 2011).

Despite this many dangers are still present in this sport. The mountain ranges in South Africa may not have all the dangers present in climbing mountains such as K2 and Mount Everest, but factors such as falling rocks, avalanches, ice slopes, and changing weather conditions might injure or create a situation that leaves the mountaineer stranded and isolated. The extreme heights experienced in mountaineering are sometimes inhospitable to sustain human life. Huey and Eguskitza (2001) refers to these inhospitable areas as *"Death Zones"*, caused by the decline in barometric pressure, which declines with altitude. As a mountaineer ascends the physiological impacts on the human body can be severe. Huey and Eguskitza (2001) identify lack of oxygen, hypoxia and dehydration as factors that will effect the human body as altitude drops.

2.4.3 Paragliding

Paragliding is an adventure sport that uses a lightweight aircraft in which a pilot is suspended in a harness, and can stay aloft for many hours. Paragliding can be a recreational or competitive activity. (Sahin, 2014) identifies paragliding as one of the most dangerous adventure sport, as it requires specialized training, conditions and knowledge. Accidents in this sport normally occur in months where the weather has increased thermal flows which leads to instability (Sahin, 2014).

Research has identified 3 main areas in which injury can be afflicted during paragliding. Zeller, Billing, and Lob (1992) states that 3 mechanisms of injury could occur during paragliding, which include start, flight and landing.

Injuries at the start of paragliding. Injuries experience at this stage of a paragliding session are normally caused due to unexpected cross winds or a pilot incorrectly using the lifting air stream. Zeller et al. (1992) identifies one-third of all paragliding accidents occur at this stage, with ankle injuries or even major spinal trauma being experienced.

Injuries during flight. Once a para-glider is airborne fewer injuries are likely to occur. Turbulence in the atmosphere could result in the lightweight aircraft rapidly falling to earth, resulting in injuries of the talus, pelvis or even the spine (Zeller et al., 1992). Strong winds could also cause the para-glider to fly off course, resulting in the individual landing in an isolated environment. To make matters worse, if the para-glider is injured, they could be left stranded, waiting for a rescue attempt.

Injuries during landing. Dangers and risks that could occur during landing may be due to turbulence or the para-glider misjudging the landing approach. Knowledge and training is vitally important during this phase as Zeller et al. (1992) identifies many dangerous factors, such as the pilot reducing speed, having to select a safe place to land and absorbing the impact of landing through their legs.

2.5 Adventure sport selected in this study

The focus of this study will be on ocean and river kayaking in South Africa. Literature has identified this adventure sport as an activity that can be enjoyed competitively or socially, but any activity in a water environment has the possibility of dangers and risk. Even with the current security parafinalia oceans and rivers are difficult to manage, whether the individual is in a remote location or not.

Unfortunately kayaking accidents do occur. Are these accidents due to the fact that kayakers neglect safety regulations? Could it be reckless behaviour? Ultimately whether the kayaker takes all the necessary precautions or not, accidents may still occur. In an attempt to obviate the dangers involved in kayaking, the South African Marine Authority (SAMSA) requires individuals to ensure the safety, marking and certifications of their vessels (Samsa, 2004).

The South African and international kayaking community have experienced situations in which an individual has gone missing during an event. These individuals are found days later and in some cases not at all, which makes any rescue attempt extremely difficult. The following events are two South African and one international occurrence in which the

kayakers were located too late by rescue teams, resulting in their deaths and thus revealing the importance of this study.

2.5.1 Incident 1

In November 2014 a surf ski contestant by the name of Mark Feather took part in the Pete Marlin World series surf ski race held in East London. During the event Mark went missing and never completed the race. According to Phandle (2014) pieces of his surf ski was found a day later near a town called Morgan Bay, approximately 20 kilometers from East London, and his body was found near Trennery's two days after the event. A massive search party of over 200 people made up of paddlers and the community attempted to assist the local National Sea Rescue Institute (NSRI), but high hopes of find Mark Feather dimmed after two days.

The following is an extract from the article written by Phandle (2014), *"Nobody knows at which point he drowned, or where he got into trouble, and what the circumstances were, if he lost a paddle, or why he was unable to use his cellphone after 8.40am, by which time he should have completed the race."* An interesting point is the mention to a cellphone in the extract. This identifies that there is a drive to use mobile technology in this adventure sport, but it is not being used effectively in search and rescue operations.

2.5.2 Incident 2

On the 3rd of September 2009, the body of a kayaker by the name of Barry Guy Marshall was found 10 nautical miles off the coast of Port Elizabeth. According to the NSRI Marshall had gone for a surf ski on the Wednesday afternoon and went missing. Friends and family only noticed Marshall was missing after he did not attend a scheduled meeting at ten o'clock that evening.

Marshall's wife and friends found his vehicle near McAuthur Swimming Bath at twelve o'clock that evening, and in turn contacted the police who then contacted the NSRI (Mousley, 2016). The following day Marshall's surf ski was found 20 kilometers out to sea and his body was located another 3.7 kilometers from the identified surf ski. The following statement was made by NSRI spokesman Craig Lambinon *"He was wearing a personal flotation device, T-shirt and baggies"*. *"He had no other safety equipment with him."* Mousley (2016) also urges paddlers to take precautions when kayaking offshore, requesting that individuals have a leash, mobile phone in a waterproof bag, flares, and informing someone of when you will arrive back from the activity.

2.5.3 Incident 3

During a white water event in the state of Virgina in America, a female white water kayaker by the name of Shannon Christy was taking part in the Potomac River annual contest. The event is renowned for its extreme difficulty and life threatening hazards, which is normally only attempted by male competitors. Christy was only 23 years of age when the tragedy occurred. During the practice sessions of the event, disaster struck as explained by Martin (2013), *"two days before the race was to start, our cameras spotted an empty kayak at the bottom of the falls. It was Shannon Christy's. No one saw it happen but somehow she had come out of her kayak."*

The three incidents that have been discussed above describe how quickly an emergency situation can occur, and how mobile technology could have assisted in search and rescue operations. If mobile technology had been used effectively in each incident, could the individuals lives been spared? In South Africa paddlers or kayakers are only required to meet certain safety standards which is discussed in the following section.

2.6 Current Safety

In South Africa before any paddler can partake in a race event the paddler must be affiliated to Canoeing South Africa (CSA) or to a local club. To promote the sport, daily permits can be issued but can only be used for a maximum of 3 races. All kayakers who participate in an event must have done a basic surf ski proficiency test (Canoeing South Africa, 2015). Part of the proficiency test and training is the water classification for South African waterways. Canoeing South Africa (2015) describes five waterway classifications namely class F, class C, class B, class A and class X.

Class F refers to any water way that has no flow or current. Class C describes any water way that has a gentle flow with some small rapids or obstructions such as tree blocks. Class B is any water way that has a steady water flow or current. Class B waterways often require significant manoeuvring to ovoid obstacles in the water way. Class A - water ways that are consistently wild, and requires advanced technical skills to paddle in. These water ways often contain extremely difficult obstacles. Finally Class X are waterways that should only be attempted by highly skilled and competent paddlers as they contain extreme currents and rapids.

Table 2.2 displays 7 items that (Samsa, 2004) recommends as safety equipment when kayaking. Event or race organisers have the right to make each item compulsory or not.

Table 2.2: Current Ocean and River Kayaking Safety Requirements (Merchant Shipping Act, 2004)

Safety Equipment	Description
Kayaking jackets	This safety item consists of foam or beaded floatation which ties around a kayaker's waist and has a quick-release buckle for emergency situations. The design of the jacket allows the kayaker torso to twist freely and does not inhibit head movement. Any kayaking jacket that is not in good working order can be rejected by the race organisers.
Helmets	helmets are made from polyethylene and are used by the kayaker to protect all areas of the head, including the forehead, back of the head and the temple. The helmet must consist of a foam lining and have a suitable chin strap to prevent the helmet from wobbling.
Boat buoyancy	According to the Samsa (2004) each kayak should have at least 10 litres of buoyancy which is mandatory. The 10 litres of bouyancy is a the minimum amount and assists the kayak in the event of it capsizing.
Spray decks	A flexible cover for a kayak or canoe that prevents water from entering the vessel. A spray deck must be streched across the cockpit and allow for a tight fit. Shoulder straps are not essential but handles for quick release in emergency situations are required.
Thermal clothing	The winter conditions in South Africa can be extremely cold and dangerous. During these seasons gloves and thermal vests are recommended. Clothes that prevent heat loss are also critical, for example thermal shoes and head wear.
Drinking systems	During a kayaking event it is vital that individuals do not become dehydrated. Enough drinking systems are vitally important in situations where a kayaker is stranded for an extended period of time. Samsa (2004) states that an individual should drink at least 250ml every half an hour in a race situation. Drinking systems are designed to break under pressure for safety purposes and must be positioned outside the kayaking jacket not inside.
Throw ropes	A non-sinking throw rope is recommended on each kayak. The rope should be approximately 20 meters long and be brightly coloured. Samsa (2004) describes that the correct use of throw ropes requires training.

It is evident from 2.2 that no safety requirements or regulations with regards to information technology and more specifically mobile technology are recommended. Mobile technology forms part of our everyday lives, yet in the adventure sport of kayaking it is not yet recognized as a vital and useful tool in assisting in rescue operations of stranded individuals. Properly used, mobile technology has the ability to help rescue teams such as the NSRI identify and locate stranded individuals in a timely and accurate fashion and thereby reduce the causalities that occur in this sport.

2.7   Conclusion

Adventure sport appeals to individuals who enjoy overcoming the challenges and risks that are not experienced in traditional type sports. The sense of conquering big waves, reaching the summit of a mountain or flying through a dangerous environment is what fuels the desire to partake in this type of sporting activity. The paradox that is experienced by these individuals is to try and make the sport as safe as possible, but still expose themselves to danger and risk that could ultimately lead to death.

Human beings have always had a sense of adventure, especially in individuals who have the (DRD4) gene which makes a person more prone to risk taking and sensation seeking. The rules and safety control of modern society causes some individuals to want to escape from everyday life, and experience the sense of freedom associated with adventure sport. South Africa's natural landscape is perfectly suited for adventure sport, with ocean and river kayaking, mountaineering or extreme hiking and paragliding being a few of the most popular adventure sports.

Unfortunately accidents do occur with this type of sport, with death being the ultimate price. Even with all the safety mechanisms and interventions in place an individual could be placed in danger. This study has revealed that many safety measures are considered before an event, but that the use of mobile technology is often neglected. This is evident in ocean kayaking where participants are required to have life jackets, drinking systems and thermal clothing to mention a few, but little emphasis is put on the use of mobile technology during an event. The following chapter deals with mobile technology that could be integrated into adventure sport to increase the safety of the participants.

Chapter 3

Mobile Technology

Mobile technology has quickly evolved from being an impractical, expensive, novelty to an extremely portable, versatile computing and communication tool.(Miller, 2014)
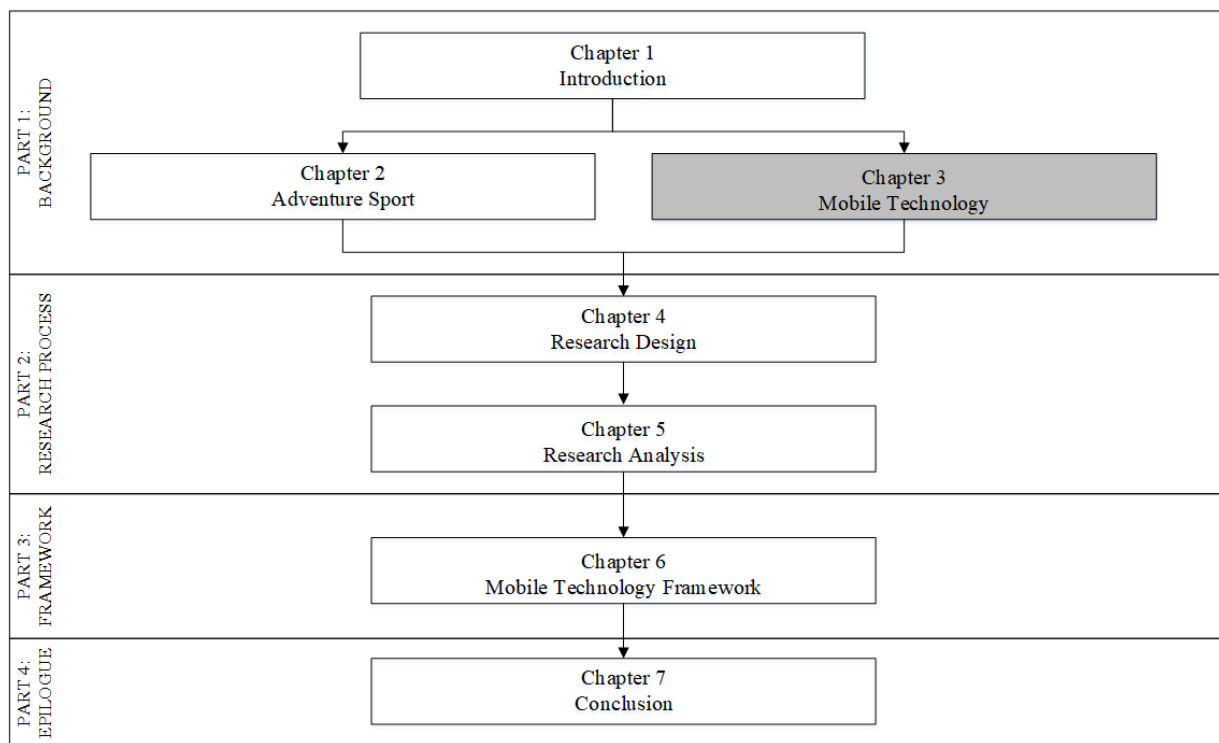
3.1 Introduction

The twenty-first century has seen a dramatic increase in the use of technology, especially with regards to mobile technology. The mobile phone is one such example. Once the mobile phone had been introduced, it surpassed the fixed line telephone resulting in an unstoppable technology. Mobile technology devices are no longer simple two-way communication devices, but offer a wide range of functions from social media to the improvement of business processes and workflow. These features are why mobile technology is so popular in modern society as it is designed by people for people.

In this chapter mobile technology will be defined. To understand the advancements in mobile technology and how it has progressed, a brief history into the mobile phone is discussed first in this chapter. After that the various layers of the mobile ecosystem are described in detail, paying specific attention to mobile applications, frameworks, mobile operating systems and devices. A link will also be established between the current relationship between mobile technology and adventure sport.

3.2 History of Mobile Technology

Mobile technology is arguably one of most successful inventions of the twentieth century. Mobile technology has bridged geographical boundaries by revolutionizing the way we communicate and interact. Brown (2002) makes the following interesting statement *"While technology has certainly changed our culture, culture itself has remade this technology in a thousand different ways."*. No one could ever have predicted the demand for mobile technology upon its inception. Brown (2002) confirms this when in the 1980s the consultancy firm McKinsey was asked by AT&T to predict how many mobile phone users there would be by the turn of the century. McKinsey confidently predicted that there would be approximately 900 000 users world wide. By today's standards, the number suggested by McKinsey is extremely low as in 2015 there were 75 million mobile subscribers in the United Kingdom alone (Banks, 2016), proving how difficult it is to predict future trends and popularity with regards to mobile technology which grows at an incredible rate.

Although any hand held device can be considered as mobile technology, the following discussion will only deal with devices that can transmit and receive data through a communication medium. According to Fling (2009) mobile technology can be segmented to five distinct eras of history which is especially evident in the history of mobile telephony, as described below.

3.2.1 The Brick Era

During this period telephones did exist, but this era marks the first time that telephones were mobile and cordless. The Brick Era occurred from 1973-1998 and the devices were very large and had limited range (Miller, 2014). These devices required a huge amount of battery power to operate and to locate the nearest cellular network, which was few and far between during this time. The phones from this era were mainly used by professional people who needed communication on the move, such as salespeople, estate agents or stockbrokers. During the 1990s these devices were added to cars to increase the mobility of the user.

3.2.2 The Candy Bar Era

The term *"Candy Bar"* refers to the design of the device being long, thin and rectangular. These mobile devices greatly improved in the first generation but were still very expensive and and larger than todays standards (Miller, 2014). During this era, people stated to identify that mobile devices were capable of doing so much more than just making phone calls, and the idea behind the short message service (SMS) was born (Fling, 2009).

3.2.3 The Feature Era

Also known as the third era from 1998 to 2008. These mobile technology at this stage could only make voice calls and send text messages. Cameras and applications or *"apps"*, as they are commonly known, were added to the phones and the common phone design was the flip style (Miller, 2014). Internet access also finally reached the devices, but had poor web page rendering and was not a popular function of the device. Fling (2009) lists high costs, poor marketing and inconsistent rendering as reasons why web browsing was not popular on these devices.

3.2.4 The Smart Phone Era

Smart phone devices have all the general functionality of standard mobile devices, but offer common operating systems, larger screen sizes, Wi-Fi connectivity and other forms of high speed connectivity. Ciaramitaro (2011) identifies text messaging, video and photo functionality, gaming, location based services, Bluetooth, Radio-Frequency Identification Devices (RFID) and WiFi as functionality to augment mobile applications. Ground breaking developments occured in this era, including Microsoft releasing their Windows CE platform, Research in Motion releasing the first Blackberry devices with push email functionality and the QWERTY keyboard was introduced (Fling, 2009). Despite all the technological advancements, the Smart Phone era still did not create the demand for the products that

the manufacturers hoped for, acquiring just 10% to 15% of the global mobile market share (Fling, 2009).

3.2.5 The Touch Era

This era has spanned from 2007 to the present day (Miller, 2014). To improve the devices in this era data speeds increased which allowed for additional features not yet experienced in previous eras. Many agree that the most influential mobile technology device was launched in this era, Apple's iPhone. Fling (2009) stated that what was so notable about the iPhone is how it changed the perceptions of how mobile technology could be used in everyday life. Mobile devices in the Touch era offer people new ways of communicating, obtaining information and the ability to pin point a device's location.

3.3 The Mobile Ecosystem and Layers

The mobile ecosystem is comprised of many different elements or layers. As shown in Figure 3.1 these elements must all work together for the functionality of the mobile device to be effective and efficient. Most individuals assume that the Internet and the mobile ecosystem are interchangeable, which in fact they are not. Fling (2009, p.13) states that this misconception could not be further from the truth, and explains that a person should image the internet as a great cloud in the sky, and the mobile device as the tool to interact with it.

To understand how the mobile ecosystem functions, the following discussion will describe each layer and how the layers are dependant on each other to provide a seamless user experience and a holistic mobile ecosystem.

| Services |
| Applications |
| Application Frameworks |
| Operating Systems |
| Platforms |
| Devices |
| Aggregators |
| Networks |
| Operators |

Figure 3.1: The Layers of the Mobile Ecosystem
(Fling, 2009)

3.3.1 Services

The services layer of the mobile ecosystem includes all the activities that a user will perform on the device. User activities range from playing games and music, accessing the Internet, using location based services and sending messages, including a SMS or data messages through applications such as Whatsapp and Blackberry Messenger for example. Goggin (2012, p. 10) identifies travel and tourism and education services as another selling feature of mobile technology.

Mobile device services in Africa alone has changed the way people perform their day to day activities. For example mobile technology is used in Africa to perform tasks such as transfer money and receiving health care assistance. The mobile technology boom in Africa is elucidated by Jidenma (2014), by describing that services are lowering information barriers in Africa by mobilizing communities and empowering governments, especially in countries such as Nigeria and Kenya. Jidenma (2014) further states that *"mobile technology is revolutionizing Africa's retail sector, access to healthcare and medical service provider's and re-creating existing industries by helping the continent narrow the digital divide."*

Despite the many challenges that exist in this mobile ecosystem layer, the future for the innovation of mobile services bright and has the potential to change the world.

3.3.2 Applications

Mobile users today use their devices not just for the standard features such as text messaging and voice calls, but are using applications on the devices for entertainment, business and educational use. Ciaramitaro (2011) states *"Not only are mobile applications the key to innovation and customer experiences, it is also a high revenue business."*

Development of mobile applications has the challenge of creating a positive user experience across different devices produced by various manufacturers. A common trend today to mitigate all the development variables associated with cross platform development is to create applications for specific platforms. Charland and Leroux (2011) states that application development in each platforms native language is expensive. By developing applications for specific platforms the time and cost associated with development is drastically reduced. To alleviate mobile device platform fragmentation, companies are turning to internet technologies when creating mobile applications.

This approach to mobile application development is a plausible solution as all devices have a browser instance that can be used and called from native code. PhoneGap is a mobile application technique created by Eric Oesterle, Rob Ellis, and Brock Whitten which allows applications created in Hyper Text Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript to be deployed to all compatible devices, reducing the mobile technology application fragmentation (Charland & Leroux, 2011). (Fling, 2009) concurs with this by stating *"Many see the web browser as the solution to this problem and the saviour from the insanity of deploying multidevice applications."*

Whether you own an iPhone, Android device or any other smartphone there is a plethora of applications for a mobile users to choose from around the world. Figure 3.2 display the top smartphone applications and the amount of users of 2015 according to (Eadicicco, 2015).
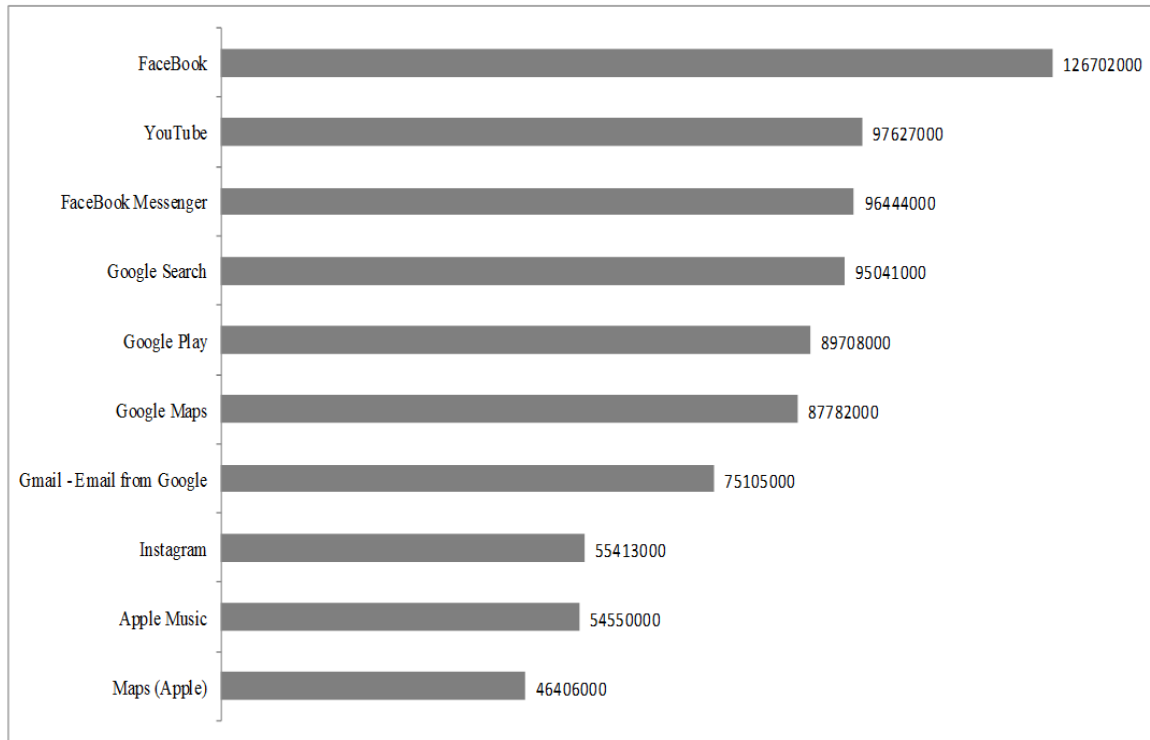
Figure 3.2: Top 10 Smartphone apps 2015
(Eadicicco, 2015)

3.3.3 Application Frameworks

The application framework is the first layer that is accessible for use by application developers. Developers make use of Application Program Interface (API) to create applications that can access the core services available through the application framework, such as security, graphic functions, location services, messaging and authentication to mention a few (Fling, 2009). The various functions of mobile operating systems are therefore made available to application developers in their application design through the application framework. The following list discusses some of the major application frameworks available for mobile application developers.

3.3.3.1 Java ME Framework

The Java ME Framework was created by Sun Microsystems with the intention of using the same source code on various devices and platforms. Mobile phones, TV-set boxes, personal digital assistants (PDA) and printers include some of the devices compatible with the Java ME framework (Grønli, Hansen, & Ghinea, 2010). This framework typically executes on multiple threads, allowing a user experience that minimises the device overhead and

prevents the application stalling or not responding. The three threads include a user interface thread, a networking thread and a data processing thread (Iliescu, 2011, pg. 25).

3.3.3.2   Windows Mobile Framework

The Windows mobile framework allows for mobile application developers to create custom applications in programming languages such as Visual Basic, Visual C# and Visual C++. Based on Windows CE 5.0, the Windows mobile framework provides an operating system for smartphones, mobile touch screen devices and PDA's (Grønli et al., 2010). A Windows mobile application developer can use the API to create applications to be deployed on any device that supports the Microsoft .NET framework. This exposes developers to a vast amount of features, including a programming layer, but limits multiple platform development as experienced with the Java ME framework.

3.3.3.3   Android SDK

Released by Google as an open source framework for application developer's to develop native applications to run on Android mobile devices. Android in fact has the ability to run on any devices that is Linux compatible. Yaghmour (2013) identifies that if you want to port Android to your hardware, you must first port Linux to use it. An open source framework allows developers full access to the device functions when developing applications (Darcey & Conder, 2012). The Open Handset Alliance (OHA) allows the Android SDK to be supported and used by many of the world's largest and most successful mobile companies around the world, including mobile device manufacturers, software developers and service providers (Darcey & Conder, 2012, pg. 20).

The Android SDK allows developers to design applications in C/C++ as well as Java which uses the Dalvik Virtual Machine (VM) (Fling, 2009). The Dalvik (VM) is custom built by Android to ensure that applications deploy and run smoothly on devices. The Dalvik (VM) handles all hardware and system services, providing and abstraction layer ensuring developers dont have to be concerned about device hardware implementation (Meier, 2012).

3.3.3.4   Cocoa Touch

Cocoa Touch is used to create applications for devices such as an iPad or iPhone. This framework contains functions such as push notifications, touch based events, multitasking and other high level system services (Apple Developer, 2014). A requirement is that once an application is developed using Cocoa Touch, it needs to be certified by Apple before being submitted to the Apple application store. Once an application is certified and available

from the Apple application store, it can be downloaded over the air or by using a cable connected computer (Fling, 2009).

3.3.4 Operating Systems

A mobile device requires an operating system to manage hardware and software resources to allow mobile applications to function. Developers of mobile operating systems have the daunting task of providing a consistent environment for the different mobile devices. To complicate matters further, device manufacturers require certain functionality to add features for the users of their devices. For example the Android operating system is used by a wide family of software vendors including Google, LG, Samsung, HTC, Sony and Motorola to mention a few (Hildenbrand, 2013). The following discussion is a list of some of the popular mobile operating systems in South Africa.

3.3.4.1 Android

The Android operating system as stated earlier is an open source operating system, which enforces little licensing restrictions. Leggett (2016) states that the licensing policy of Android grants anyone to develop applications for the devices, and allows users to benefit from a mass of free content. Android is still considered one of the mobile operating systems that still shows growth (GSMArena, 2016), which is an impressive feat in the competitive mobile technology industry. Currently the best features of the Android operating system is the ability to customize multiple home screens and excellent multitasking, allowing a user to simply swipe an application away to close it (Leggett, 2016).

The Android operating system has alleviated the difficulties experienced by users on other operating systems. Pattnaik and Mall (2015, pg. 200) states how Android has helped overcome these challenges, as discussed in Table 3.1.

Table 3.1: How Android overcomes operating system challenges

Challenge	Description
Various input methods	Android allows for phone-based or touch screen input from the user, remedying the different interaction styles of mobile devices.
Web browser experience	Android provides a full scale web browser to view web pages, not just simplified mobile versions of the page.
Development of third party applications	Application developers can develop applications for the Android operating system using the software development kit and framework provided by Android. Application development for this open source platform is promoted and encouraged, compared to other mobile operating systems which do not expose internal functions to developers.
Open source community	Android runs on technology and programming languages that many developers have been exposed to, creating a support base for other developers.
Storage of persistent data	SQLite is a relational database management system that is provided with the Android operating system, allowing application developers to save content to a database.
Pre-Installed applications	The Android OS comes pre-installed with many useful applications for a user to make use of, including Google maps, Google Play Store and Gmail for email functionality.

3.3.4.2 Windows Mobile

Developed by the Microsoft Corporation, the Windows Mobile operating system also known as Windows Phone, is designed to operate on mobile devices such as PDA's, tablets and mobile phones. Microsoft is the only other company to truly compete with Apple and Google in the mobile operating system market, by purchasing Nokia's cellphone business in 2013 and thereby gaining licenses to Nokia's patents and mapping services for the next 10 years (Woyke, 2014). Microsoft's goal in creating Windows Mobile (OS) is to provide a common user interface and functionality among the different devices. The intent is to make the mobile devices produced by different manufactures appear uniform (Pattnaik & Mall, 2015) . Windows Mobile provides applications such as Microsoft Office, Windows Media Player Internet Explorer and secure email accounts with push support to mention a few (Leggett, 2016).

Pattnaik and Mall (2015) identify many important features associated with the Windows mobile operating system. Firstly the Graphics/Window/Event (GWE) manager is a component that controls and handles all the input and output requests of the user. Secondly the Windows mobile operating system is equipped with virtual memory management, which allows multiple applications to run simultaneously. Thirdly a cryptographic library

provides security, and finally developers who design applications for Windows 32 bit environments will feel at home as application development for the Windows mobile environment is very similar.

3.3.4.3   Apple iOS

Originally known as the iPhone OS, iOS is the operating system used on Apple mobile devices, including Apple TV, iPhones and iPad's. This mobile operating system is not open source and fully owned and controlled by Apple (Pattnaik & Mall, 2015). A closed and proprietary OS means that other device manufacturers do not have a license to use or install iOS on their devices. Apple's iOS has enough market share and popularity to keep iOS platform specific. Popular features that keep market attention include user gestures such as screen pinch or tap, accelerometers triggered by user movements and crystal clear displays.

3.3.4.4   RIM Blackberry OS

The Research in Motion (RIM) Blackberry OS, as with Apple's iOS is a closed and proprietary operating system. Therefore no other hardware manufacturer uses the Blackberry OS. An interesting aspect of Blackberry devices is that some models use the Blackberry OS, while others use Android, for example the Blackberry PRIV device. The Blackberry PRIV according to (Blackberry, n.d.) integrates the messaging experience and ecosystem of applications available to Android with the combined security of Blackberry.

3.3.5   Platforms

In order to develop software for mobile devices, a particular platform or language is required. Three types of software platforms exist according to (Fling, 2009, p. 20), namely licensed, proprietary and open source platforms.

Licensed platforms are purchased by mobile device manufacturers to create a common platform to be used by all the manufacturers devices. Two licensed platforms as stated by Memon (2013, p. 6) are the Java Micro Edition (Java ME) and Windows Mobile. Proprietary platforms on the other hand are designed by the mobile device manufacturers for use on their own mobile devices. Two major proprietary platforms are Blackberry and iPhone (Fling, 2009, p. 21). An Open Source platform is very different than licensed and proprietary platforms in that it is freely available for download and editing. Android is the leader in the open source arena and does not limit the users to a narrow selection on mobile devices (Memon, 2013). Table 3.2 provides an overview of the mobile technology platforms.

Table 3.2: The three software platforms to develop mobile software applications

Platform Type	Purpose	Audience	Examples
Licensed	To create a common platform to be used by all the manufacturers devices	Device manufacturers	Java ME, Windows Mobile
Proprietary	Created by device manufacturers for their devices.	Device manufacturers	Blackberry, iPhone
Open Source	Freely available and not device specific	Device Manufacturers and End users	Android

3.3.6 Devices

Mobile technology evolves at an incredible pace and is at present more powerful and minuscule in size than ever before. Ewert, Sibthorp, and Sibthorp (2014) suggest that smartphones, wearable sensor devices, mobile computers, GPS devices, pagers and personal locator beacons have had the biggest impact on outdoor adventure activities.

3.3.6.1 Smartphones

Also known as mobile phones which consist of advanced application programming interfaces (APIs), processing power, connectivity abilities and GPS navigation. Modern smart phones include touch screens, internet browser functionality, and high-speed data connection using Wi-Fi and mobile broadband. Currently the mobile phone industry has many different brands of smart phones, but after Apple and Android devices started to gain momentum, smartphones need to become more like mobile computers to be effective in the market (Woyke, 2014).

As figure 3.3 depicts the industry leaders in the South African market include Apple devices using the iOS operating system, Samsung and Sony devices using the Android operating system, Nokia devices using Symbian or Windows Mobile Operating System and Blackberry using Blackberry OS or more recently the Android operating system.
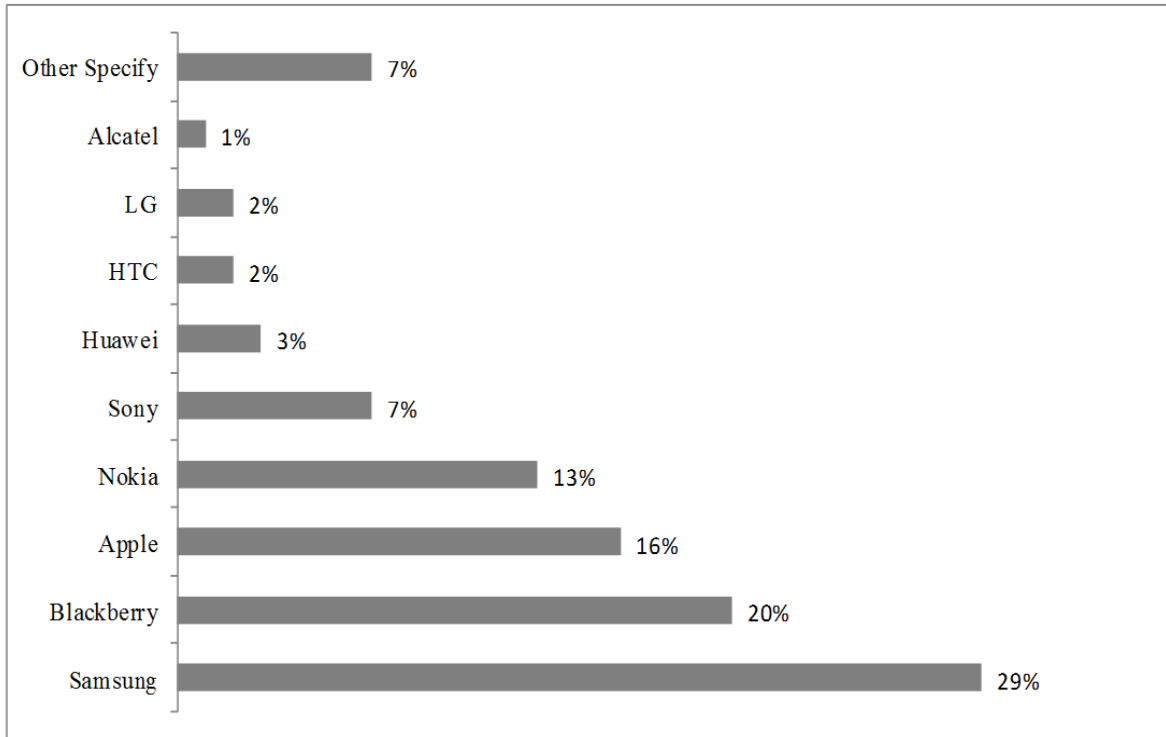
Figure 3.3: Smart Phone Preferences in South Africa
(ITWEB, 2015)

3.3.6.2 Wearable Sensor Devices

A new non-restrictive technology that is finding popularity in sport. Salvo (2013, p. 2) posited that, *"the main advantages of this new technology is that the modified garment does not alter the normal activity of the user"*. Recent developments into wearable devices include integrated GPS functionality and water resistance casings, providing a convenient device that can be used during adventure sporting events.

3.3.6.3 Mobile Computers

Devices that cannot be physically used by an athlete during a sporting event due to their weight and size, but are an invaluable tool for performance analysis after a sporting event. Mobile computers provide a connection to mobile devices, such as smart phones or GPS sensors, so data can be transferred for analysis purposes. Rowlands and James (2011) identify wired and wireless connections as two ways of extracting data from a sensor unit or other mobile device to a computer.

3.3.6.4   GPS Devices

Most commercial GPS systems and devices use audio and visual commands to direct the user to their desired destination, for example the conventional street navigation system available in cars. GPS devices use satellite based navigation to continuously provide time based location information to track an individuals movements. Thompson (2003, p.3) describes Global Positioning System (GPS) as, *"a satellite-based navigation system consisting of a minimum of 24 satellites and their ground stations which monitor the GPS satellites, checking both their operational health and their exact position in space"*.

3.3.6.5   Personal Locator Beacons (PLB)

Technology primarily used in marine and aircraft vessels but can be used in land based events. According to (Rainczuk & Schmidt, 2008) PLB devices are used in search and rescue operations to locate people. PLB devices have the added benefit of a highly intensive flashing led along with a distress signal to alert emergency personal of an individual's location in low visibility conditions. Tognazzini (1999) states that the distress signal of a PLB is used by rescue teams to become aware of an emergency and to locate the emergency site by performing triangulation on the detected signal.

3.3.7   Aggregators

An Aggregators prime function in the mobile ecosystem is to reduce the strain of forwarding or aggregating traffic to application service providers. Aggregators serve multiple devices and users by forwarding transmissions in an economical way (SearchNetworking.TechTarget, 2016). Vodacom (n.d.) provides a list of Aggregators that serve the South African market, providing services such as application development, bulk messaging, increasing customer engagement and Unstructured Supplementary Service Data (USSD) for location based and mobile money services.

3.3.8   Networks

Mobile networks are used to provide voice and data capabilities to devices. This technology is simply a radio signal that the device receives from an antenna. Fling (2009) states that it is the radio and antenna that ultimately determines the capability of the network and services that are available.

The first generation of mobile networks only supported voice and not data communication. The second generation 2G introduced Groupe Special Mobile (GSM) which supported voice services and data connections (Rodriguez, 2015, p. 136). An evolutionary upgrade to

the 2G network was the General Packet Radio System (GPRS), which provided an increase in the data communication speed. 3G networks succeed the 2G networks by supplying faster data speeds and the ability to make video calls. At present Long Term Evolution (LTE) networks, also known as 4G, are becoming the industry standard for mobile communication (Rodriguez, 2015, p. 136). South Africa according to Rawlins (2015) has the tenth lowest 4G speed, with an average speed of 8 megabits per second (mbps) and a coverage of 58 percent.

3.3.9 Operators

Operators, also known as mobile service providers, are the telecommunication companies responsible for bringing the mobile ecosystem to life. Operators provide customers with devices, cellular towers and services such as internet connection. Business Tech (2015) states that the major mobile network operators in the South African market are Vodacom, the MTN Group, Cell C, Telkom Mobile and Virgin Mobile.

With regards to the major operators in South Africa, Virgin Mobile is the only operator in the list that is a mobile virtual operator (MVNO), which is an operator that does not possess its own network infrastructure, but rather uses other network operators to provide services to its customers. In South Africa MVNO's currently run off Cell C infrastructure, which is the only operator to have created a business aimed at attracting MVNO's (Mochiko, 2015).

3.4 Mobile Technology and Adventure Sport

Previously in this chapter it was discussed that the mobile technology industry has many manufacturers, devices and software available for an individual to choose from. In this study the focus is on using mobile technology to improve the safety of individuals partaking in adventure sport, which reduces the range of mobile technology options available to an individual due to size constraints and water proofing for example. Mobile technology with regards to safety aspects can be viewed from a software and hardware perspective. The following discussion deals with hardware and mobile device applications that are currently used in an attempt to improve the safety of an individual and could be used in adventure sporting events. It is apparent from the discussion below that each technology has its own advantages and disadvantages, and that a framework is required to propose the effective use of mobile technology with regards to adventure sport safety.

3.4.1 Hardware Devices

The following section provides an overview of three mobile devices that have gained popularity in the adventure sporting community.

3.4.1.1 Duotraq DQ30 Handset

The Duotraq DQ30 Handset is a waterproof handheld device with embedded GPS functionality used to track individuals participating in adventure activities. The device is not particularly aimed at the adventure sport industry, but according to (Duotraq, 2016) is used in tracking individuals using vehicles, boats and other movable transportation systems. The device has the added benefit of providing a battery service of 400 hours standby time and 140 hours continuous tracking. An emergency message can be sent by the press of a button to the Duotraq tracking server and an emergency email or SMS message to a contact person via GPRS.

Figure 3.4: The DUOTRAQ DQ30 Handset
(Duotraq, 2016)

3.4.1.2 SPOT GEN3 Handset

The Satellite Personal Tracker SPOT GEN3 device provides tracking services virtually on every continent including portions of North and South Africa. Russia is the only location where GPS tracking is restricted according to Russian regulations, therefore limiting the functionality of the SPOT GEN3. The device provides emergency location based communication from remote locations around the world (SPOT, 2016a). Motion activated tracking and long battery life are key benefits of the device. The SPOT GEN3 Handset contains an SOS button that notifies the International Emergency Response Coordination Center that an adventurer is in distress. The International Emergency Response Center then contacts local police and rescue teams in a close proximity to the individuals GPS location.

SPOT targets a wide market range by providing a list of adventure activities that should use the device on the official website (SPOT, 2016b). Kayaking and canoeing are included in the list as the SPOT GEN3 is water resistant and can float in emergency situation.

Figure 3.5: The SPOT Gen3 Handset
(SPOT, 2016c)

3.4.1.3   G-Layer YB3 Handset

The YB3 device provides the user with the ability to send and receive messages anywhere on the planet. The YB3 device has the ability to operate in areas where WiFi and GSM networks are unavailable (G-Layer, 2014a). The YB3 devices operates in a silent mode, establishing GPS coordinates on a regular basis. These coordinates are then transmitted to the organization's headquarters and the individuals location can then be visually plotted on a map.

This mobile technology makes use of the Iridium satellite network, which has 66 satellites in operation to provide global coverage (G-Layer, 2014a). Using the YB3 and Iridium network services are not free and therefore require monthly rental charges which must be taken into consideration before adoption.

Figure 3.6: The YB3 Handset
(G-Layer, 2014b)

3.4.2 Mobile Applications

The mobile application market has a vast amount of application's that can be used to improve and evaluate sporting performance. Not all of the mobile applications are aimed at the safety aspects of sport and adventure sport in particular. The following two mobile applications have been designed with sporting performance and safety in mind.

3.4.2.1 RSA SafeTrx

RSA SafeTrx is a free application that has been launched in South Africa by the NSRI. The application has had success globally in assisting with the search and rescue of paddling and small crafts (NSRI, 2017). The application is available for download to smartphones and monitors the individual's journey.

The application logs the individual's position every kilometer or 5 minutes. An added benefit is that the application monitors the battery level of the device, and if the battery level falls below 10% the application will shutdown to preserve battery power for emergency calls.

A breadtrail on a map is also provided to monitor the journey travelled. Finally if the individual trip is overdue, the emergency contact list is notified so that a search and rescue attempt can be organized if required.

3.4.2.2 LIFE 360 Mobile Application

Life 360 is a mobile technology application available for download on Windows Phone, Android and iPhone. The software is designed for family members to keep track of their loved ones, but has the possibility to be used by individuals who partake in adventure

activities. Life 360 eliminates the need for constant text messages and phone calls to determine if a family member arrived safely at their destination. A user of the application simply has to open the software on their mobile device to see their contact's location on an embedded map.

An initiative for Life 360 is the partnering with the automaker BMW to integrate their tracking service into vehicles (Perez, 2013). The initiative allows a driver to navigate to a contact person's location, instead of a physical location.

3.4.2.3   Endomondo Mobile Application

Endomondo is considered one of the most popular sports tracking and fitness management applications and is available on numerous mobile platforms including iPhone and Android. Any type of sport can be used with Endomondo including adventure sport such as ocean or river kayaking. Considered more as a mobile personal trainer, the application does have the ability to monitor and track the mobile device via GPS (Khan, Ananthanarayan, Le, & Siek, 2012).

Endomondo provides statistics and visual representation of an individual's speed, heart rate, and altitude travelled during a sporting activity. Social media is also incorporated into the application by providing an individual's workout or events posted on Facebook or Twitter (Vickey & Breslin, 2012).

Endomondo has the building blocks to be an application that can be used in emergency situations with features such as GPS and proving an individual's location and movements via social media.

3.4.2.4   Kayaklog

Kayaklog is a mobile application available on the iOS and Android platforms. Vital environmental factors such as an individual's trip duration, wind speed and temperature is gathered and presented to the user (Matthews, 2015). Kayaklog's custom website enables the kayaker to upload and store their progression and share statistics on social media.

A professional addition of the mobile application is available on a 12 month subscription which offers GPS positioning and emergency contact lists.

3.4.3   Adventure Sport Mobile Technology Summary

Table 3.3 provides an overview of the adventure sport technologies discussed in this chapter. Only the base options of the various technologies are listed in Table 3.3. It must be

stipulated that other versions or editions are available for purchase or monthly subscription by an individual.

By comparing the various technologies in a tabular format, it becomes evident that certain technologies are aimed at different adventure sporting competence levels. For example, more experienced individuals might tend to use the hardware tracking systems, compared to the software technologies used by novice adventure sport participants. Table 3.3 provides vital information for the formulation of a framework in this study as it identifies the type of technologies available, whether a free edition is available, and most importantly if there is tracking and emergency response functionality.

Table 3.3: Summary of mobile technology features

Technology	Hardware	Software	Free Edition	Tracking Functionality	Emergency Response
Duotraq DQ30 Handset	✓			✓	✓
SPOT GEN3 Handset	✓			✓	✓
G-Layer YB3 Handset	✓			✓	✓
Life 360		✓	✓	✓	✓
Endomondo		✓	✓	✓	✓
Kayaklog		✓	✓	✓	✓
RSA SafeTRX		✓	✓	✓	✓

3.5 Conclusion

Mobile technology has developed and evolved drastically in the last few decades. Even though its origins can be traced back to the beginning of the century, the mobile technology we know and experience today has sky rocketed from the humble introduction of two way radios to the sophisticated smart phones we possess today. The mobile phone has evolved from a simple voice only device in the brick era to the touch era that we are currently experiencing, providing new ways of communicating, obtaining information via mobile browsers, fast network connections and the ability to pin point an individuals exact location using GPS technology.

To fully understand mobile technology it needs to be conceptualized into layers. These layers are commonly known as the mobile ecosystem that can be divided into nine distinct

layers, consisting of services, applications, application frameworks, operating systems, platforms, devices, aggregators, networks and finally operators. The major force driving mobile technology are the physical devices consisting mainly of smart phones, wearable devices and GPS devices. Each of these devices require an operating system to function correctly and provide the user with features. The main mobile operating systems for these devices include the Android operating system, Windows Mobile and Apple iOS. Vodacom, the MTN group, Cell C, Telkom mobile and Virgin Mobile are the major operators that provide cellular towers and mobile subscription services to the South Africa mobile market, whereas there is a growing new business providing MVNO's with the opportunity to enter this fierce and competitive industry.

Every facet of technology advances at an incredible rate, and mobile technology is at the forefront of new developments. If we look back at the last decade and appreciate the developments that have occurred, we can only dream and imagine what the future decades will hold for mobile technology. The following chapter presents the research design and process used in this study.

Chapter 4

Research Design

If we knew what it was we were doing, it would not be called research, would it? - Albert Einstein
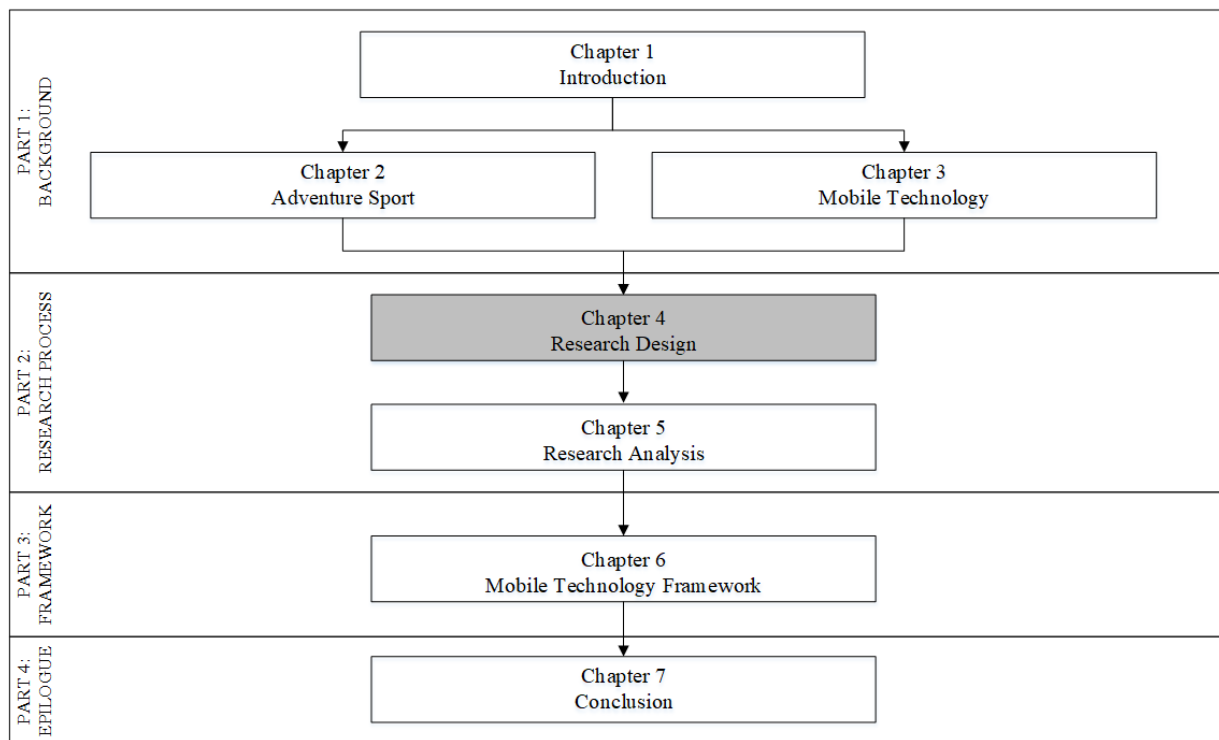
4.1 Introduction

Research can be considered as a way of thinking that incorporates a set of skills such as questioning, exploring and observing to understand a particular phenomenon to obtain information.

This chapter examines the research methodology used in this study. The research paradigm is discussed as well as the research design and processes that were followed. This chapter ensures that sound and methodical research processes were employed to ensure the validity of the study.

4.1.1 Research Paradigm

In order to reach the objectives in this study, it is important that methodical research processes be followed based on an acceptable research paradigm. Many research paradigms exist, two of which are the positivism or quantitative and the phenomenological or qualitative paradigms. Oates (2005, p. 13) states that, a research paradigm provides the researcher with a means to create patterns and models or a collaborative way of conceptualizing about the world.

Qualitative research is exploratory in nature, which provides insights into an identified problem. It is also used to uncover trends in thought and opinions, and dive deeper into the problem (Wyse, 2011). Qualitative research in this study will be obtained from conducting a literature review and will be used to theoretically establish what concepts and components could be included in the design of a framework. Quantitative research uses numerical data, transformed into usable statistics to quantify opinions, behaviours and defined variables (Wyse, 2011).

Quantitative data in this study will use data obtained from a questionnaire to determine what mobile technology is currently used by adventure sport participants and emergency response team members. Questionnaires are used in research for the collection of data such as personal preferences, social attitudes, beliefs, opinions, behaviour patterns, group practices and habits (Kumar, 2002).

There is not always a clear distinction between quantitative and qualitative research, as both have processes to be followed to achieve research objectives (Fox & Bayat, 2011). Since this study is both quantitative and qualitative in nature, a mixed research paradigm will be used to produce findings. The premise of using mixed research methods according to Creswell and Clark (2011, p. 5) is that, *the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone.* Data obtained from the mixed research methods will be interpreted impartially.

4.1.2 Research Design and Process

Research design is a detailed plan consisting of data collection strategies for obtaining answers to a research problem. The research paradigm discussed earlier was used in the formulation of the design and processes used in this chapter. Kothari (2004) states that research design is important as it facilitates the various research procedures efficiently while obtaining maximum information. The research methods in this study are represented in Figure 4.1 consisting of a literature review and a questionnaire to obtain data to be analysed for the purpose of devising a framework.
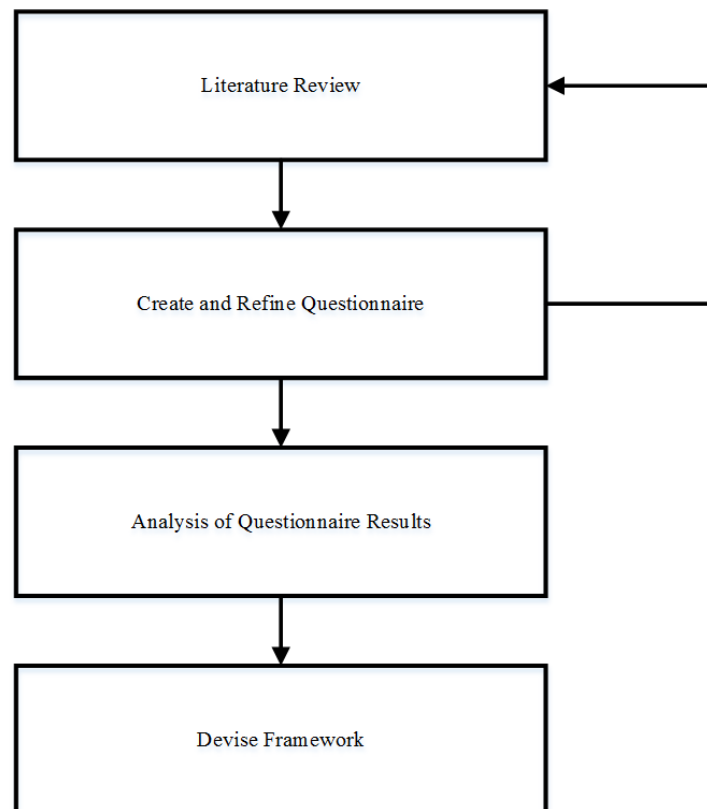
Figure 4.1: Research Methods

The research design and process used during this research study is graphically depicted in Figure 4.2 and comprises of the following :
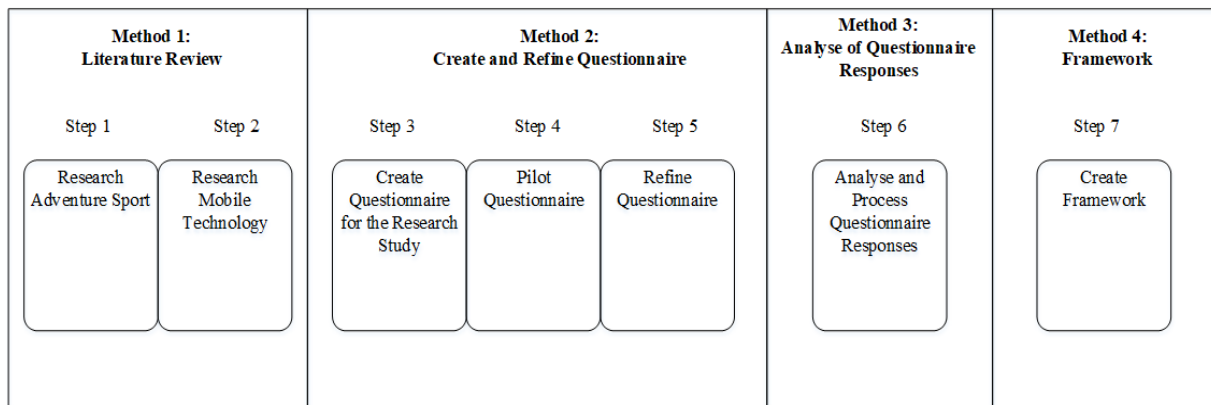
Figure 4.2: Research Process

4.1.2.1 Research Process: Method 1

Two literature reviews were conducted in this study, as depicted in Figure 4.3 to describe the phenomenon of adventure sport and to identify mobile technology that is currently being used by the participants in this extreme sport. Limited books, academic papers and journals were available on the concept of using mobile technology in adventure sport, therefore separately researching each field was required to produce suitable information in this study. Knowledge obtained from the 2 literature reviews addressed the primary research and third secondary research objective in Chapter 1 Section 1.4. The knowledge obtained on the concepts and components were then incorporated into the framework created in this study (as discussed in Chapter 6 Section 6.2).
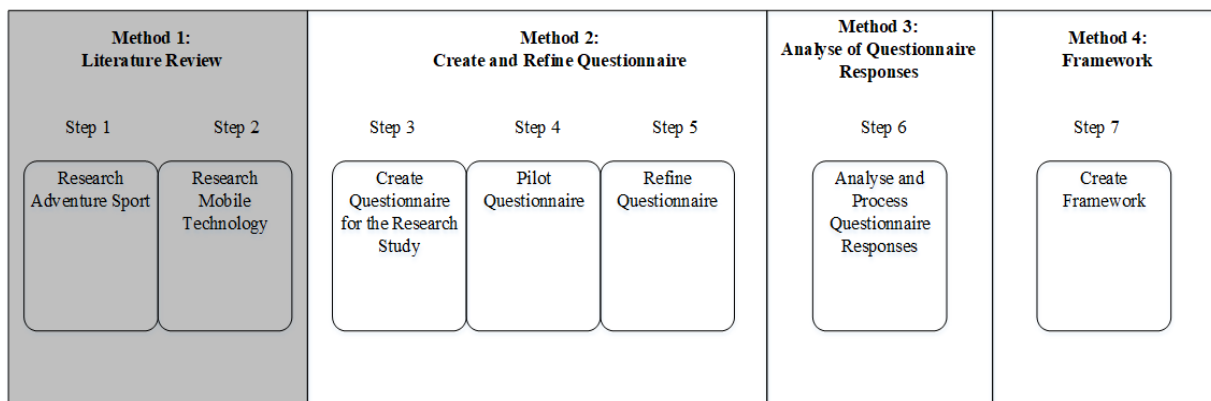
Figure 4.3: Research Process: Method 1

The literature review adopted the suggestions of USCLibraries (2015) by using articles, books and other information sources to obtain description, summary and critical evaluation

on a particular research problem. The literature review also identified current mobile technology used by adventure sport participants as well as rescue workers during search and rescue operations. The literature review analysed various sources to obtain a broad understanding of safety related issues pertaining to adventure sport. Areas in which mobile technology is lacking and where it could be used to increase the safety of adventure sport will be identified.

4.1.2.2 Research Process: Method 2

This study used a questionnaire comprised of open and closed ended questions, conducted during Process 2 identified in Figure 4.4. Open ended questions allow a respondent to provide their own answers to questions. Open ended questions will encourage participants of adventure sport to comment freely on the topics that have been put to them (Fox & Bayat, 2011), whereas closed ended questions contain a fixed number of answers from which a respondent has to select one (Du Plooy, 2009, p. 153). The questionnaire was also used to establish past behaviour on situations where mobile technology has or could help in increasing the safety of individuals participating in adventure sport.

The questionnaire participants were selected from a diverse group comprising of different ages and adventure sport experience. The data obtained depended on the willingness of the adventure sport participants and emergency response teams in completing the questionnaire. Chapter 5 provides an in-depth discussion on the questionnaire planning process, and the types of questions used in the creation of the questionnaire for this study.

Method 2 addressed all of research objectives discussed in Chapter 1 Section 1.4. Each of the objectives assisted in creating the questionnaire in Chapter 5 which was used to formulate the framework in Chapter 6 Section 6.2.
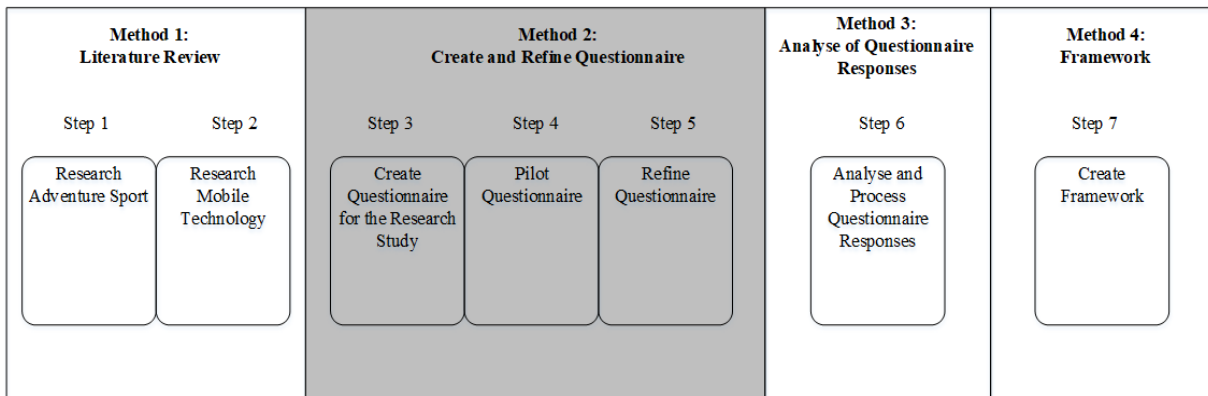
Figure 4.4: Research Process: Method 2

Data analysis in this study involved processes to provide clear answers to the research questions stated in Chapter 1. Data analysis comprised of analysing the data obtained in the form of independent and dependent variables and creating graphical representations of the data. Moser and Kalton (1977) identify three important checks that were performed on the data obtained from the questionnaire before analysis was conducted, namely completeness, accuracy and uniformity.

Completeness: Checks were performed on the questionnaire data to ensure that all questions were answered. Completeness was ensured by including a not applicable option to certain questions.

Accuracy: Accurate data was obtained by ensuring that all questions were answered correctly. Accurate data is important as errors or incomplete data could have reduced the validity of this study.

Uniformity: This check involved the researcher ensuring that respondents understood and interpreted the questions in the same manner. Moser and Kalton (1977) state that this check is vitally important as a researcher my record the same answer multiple times instead of once.

The piloting and revising process of the questionnaire ultimately removed most errors that could have occurred during the data collection process. Without the piloting and revising of the questionnaire data analysis might have been drastically effected. Chapter 5 provides a thorough overview of how data was analysed, processed and visually represented. Method 3 addressed all of research objectives discussed in Chapter 1 Section 1.4 as an analysis of each of the questionnaire responses was required in the formulation of the framework in Chapter 6 Section 6.2.

Figure 4.5: Research Process: Method 3

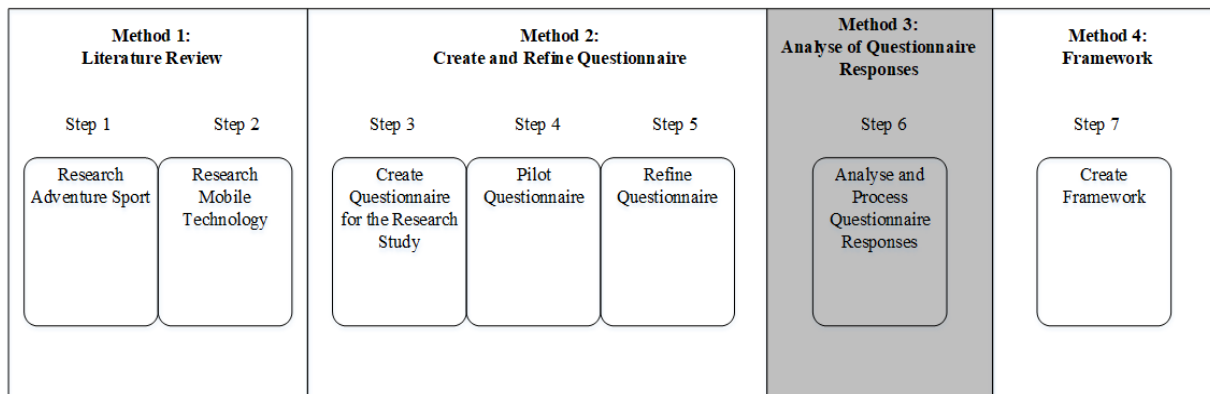#### 4.1.2.4 <mark>Research Process: Method 4</mark>

Process 4 concludes the research methodology of this study by creating a framework. According to Rogers, Sharp, and Preece (2011, p. 57) a framework provides a variety of forms which include concepts, steps, questions, challenges, principles, tactics and dimensions.
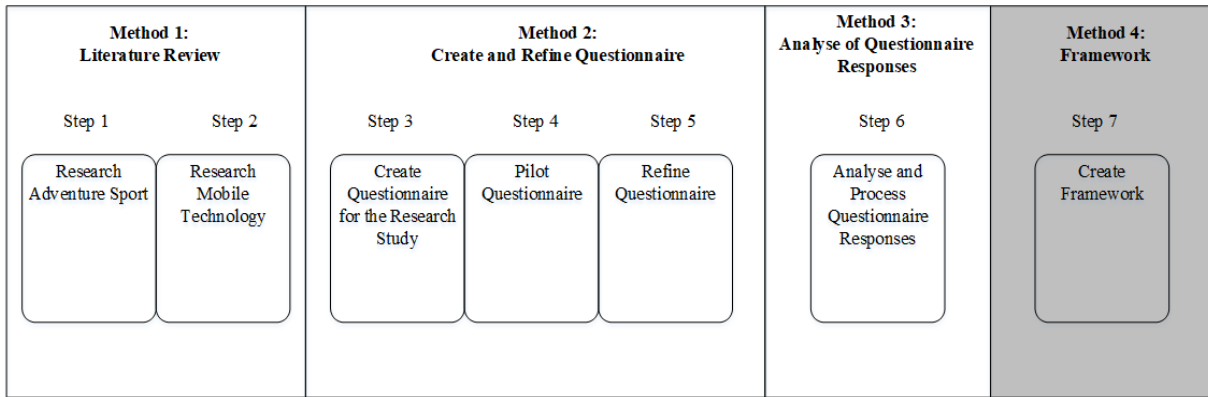
Figure 4.6: Research Process: Method 4

The proposed framework in this study will consist of 3 steps. Firstly, the framework will address the problem of integrating mobile technology into adventure sport for the purpose of increasing the participant safety. Secondly the framework will address how emergency response teams can use the benefits of mobile technology to assist in search and rescue operations of stranded adventure sport participants. Finally a complete framework will be proposed based on the concepts and components identified by the previous two steps. The creating and compilation of the framework is discussed and presented in chapter 7.

The literature reviews conducted in Chapter 2 and Chapter 3 led to the development of a questionnaire that was used in this study. In this chapter, the questionnaire design is discussed paying special attention to how the questionnaire population was determined, the types of questions that were used to obtain results and what graphical means were used to visually display and communicate findings.

The questionnaire was first piloted against a select few members of the adventure sporting community of ocean and river kayaking, to test the relevancy of the questionnaire and to allow for improvements. The main deliverable of piloting the questionnaire and of this chapter was to obtain a refined, unambiguous questionnaire, which was free of errors and would not lead participants in answering questions. <mark>The final research method addressed research objective 3 in Chapter 1 Section 1.4. Data obtained from the previous research methods and the primary research objective resulted in the formulation of the framework in Chapter 6 Section 6.2.</mark>

4.2   Questionnaire Design

An eight stage sequence adapted from Cohen, Manion, and Morrison (2011, p. 435) was implemented when planning and designing the questionnaire for this study. The questionnaire planning process is graphically depicted in Figure 4.7.
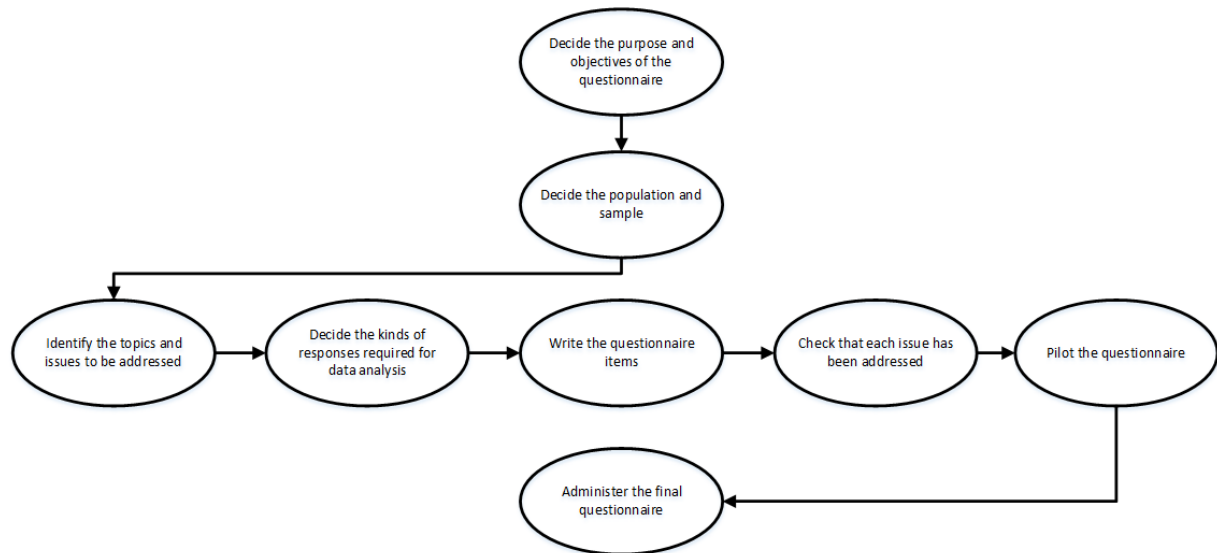
Figure 4.7: Questionnaire Planning
(Cohen et al., 2011)

4.2.1   Decide the purpose and objectives of the questionnaire

The first stage taken in this study when planning the questionnaire was not to start writing the questions, but to determine what information is required from the respondents in order to meet the research objectives stated in chapter 1. The literature reviews conducted in chapter 2 and 3, along with a number of small informal question and answer sessions with adventure sport participants clarified some aspects about the information that is required from the questionnaire.

4.2.2   Decide the population and sample

Determining the population size to participate in this study proved to be an intricate process as the entire adventure sport population of South Africa could not participate in the questionnaire. Therefore a research sampling method had to be determined to represent the population of the adventure sporting community in the Eastern Cape. By using a sample of the adventure sport population, valuable resources such as time was saved as the

population size was not too big, but valuable insight into the study could still be obtained as the population size was not too small.

Upon determining the sampling method certain factors had to be considered, such as the adventure sporting community of the Eastern Cape is not extensive and appeals only to a certain culture. This is validated by Wheaton (2004, p. 6) who states that participants of these lifestyle sports are predominately from the privileged white male middle classes.

Many sampling techniques were considered and evaluated to determine their effectiveness to be used in the study. A difficulty in determining the population in this study was that little or no prior research had been done on adventure sport in the Eastern Cape, and therefore very limited literature on the subject was available. Therefore the researcher implemented Volunteer and Snowball sampling. Ten prominent paddling clubs were contacted and requested that their members voluntarily participate in the study. Each volunteer was also requested to recommend another individual not in their club to complete the questionnaire. These two sampling methods were ideally suited to this study as it would be difficult to exactly state how many kayakers were in the Eastern Cape.

Furthermore the sampling methods also provided valuable information as each club member and recommended participant had various ages, genders, ethnic groups and skill levels. O'leary (2004)[p. 110] states that volunteer sampling is suited to studies where participants are interested in the phenomena and are therefore likely to participate. Further justification for the inclusion of snowball sampling was obtained from (Emerson, 2015) who postulates that participants are from the same geographic area as well as similar socio-economic statuses or ethnic backgrounds, which proved true for this study.

4.2.3   Identify the topics and issues to be addressed

When generating the topics and issues to be addressed in this study, the researcher already had a general idea of the questionnaire items. More specifically the grounding of the topics and issues to be addressed in the questionnaire had been identified in Chapter 1 from the research questions and objectives. These items formed the basis for the questionnaire items and were used to generate the data required for analysis. The literature review conducted in Chapter 2 and Chapter 3 were also used in the formation of the questionnaire topics and issues.

4.2.4   Decide the kinds of responses required for data analysis

Obtaining responses to a research questionnaire can often be a difficult endeavour. Giesen, Meertens, Vis-Visschers, and Beukenhorst (2012) states that researchers often overlook the difficulty in getting a respondent to complete a questionnaire correctly. The following

steps are defined by (Giesen et al., 2012) which guided the process of deciding the kinds of responses required for data analysis.

Step 1: Comprehension of the question: Involves the respondent attempting to understand the requirements and the posed question. Each question created in the questionnaire was created with comprehension in mind.

Step 2: Information retrieval: The process of the respondent recalling stored memory information on the particular matter. The questionnaire did not require participants recall a vast amount of information, only to reflect in their own experiences of ocean and river kayaking.

Step 3: Information judgement: This step occurs when the respondent extrapolates the information retrieved in step 2. Each judgement made by the participants was unique as each individual had different experiences in ocean and river kayaking.

Step 4: Reporting and responding an answer: Once the respondent had understood the question and recalled memory on the subject could an answer can be conveyed in an overt manner.

During the planning and preparation of the questionnaire, data analysis of the responses was kept in mind. In this study a combination high level data analysis and simple frequencies implemented through a range of questioning styles provided reliable data on the subject. The constructed questionnaire design could either have be structured, semi-structured or closed in nature. Cohen et al. (2011, p. 381) states that if the population size of the study is large then the more structured and closed the questionnaire needs to be. Therefore as identified earlier in this chapter, the sample size in this study is not large being a niche subject area. Therefore a semi-structured questionnaire provided data for analysis through a series of questions presented to the participants. A semi-structured questionnaire will allow responses to be clear, open-ended and sequenced without presupposing the nature of the responses (Cohen et al., 2011, p. 382).

4.2.5   Write the questionnaire items

There are many different ways to present questionnaire items. Each questionnaire technique used in this study required planning to determine the desired response modes of the participants. The following outlines the type of questions used in the formation of the online questionnaire this study.

4.2.5.1   Dichotomous Questions

This questioning style was used as it requires the participant to select a yes/no response or a choice between two dichotomous variables. The dichotomous questions prevents the

respondents from sitting on the fence with regards to a question (Cohen et al., 2011, p. 383). By implementing this questioning type the respondents would not be able to guess answers. One concern with this questioning style is it has a tendency for a bias response. The following is an example of a dichotomous question used in this study:

Unfortunately accidents do occur in adventure sport. Have you ever been in a situation or witnessed an incident that left you or another individual stranded, waiting for emergency rescue.

$\bigcirc$ Yes

$\bigcirc$ No

4.2.5.2 Ranking Questions

Rank order questions allow the respondents to supply their order of preference from a predetermined list of options. Brace (2008, p. 61) states that ranking questions can be used to differentiate between various items related to the study, in this case mobile device brands, products and even services. Below is a representation of how ranking questions were implemented in this study.

On a scale of 1 to 5, if a mobile device application was made available in attempt to increase the safety of your adventure sport, would you consider changing your existing smart phone to use the application?

	1	2	3	4	5	
No	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	Yes

4.2.5.3 Closed-Ended Questions

Closed ended questions presented the respondents with a range of possible options to choose from. Closed questions have the benefit of generating frequencies of statistical analysis and are quicker to analyse than open questions (Cohen et al., 2011, p. 382). This questioning style was used extensively in the online questionnaire as valuable data could be obtained without adding time constraints and thereby not frustrating the respondents. The following question is an example of how closed ended questions were used in this study:

Please indicate which adventure sport you currently partake in?

⭘ River Kayaking

⭘ Ocean Kayaking

⭘ River and Ocean Kayaking

4.2.5.4 Matrix Questions

Matrix type questions present the respondent with identical responses for different questions. A common example is to use the responses *'Strongly Disagree'* or *'Strongly Agree'*. Matrix questions allow the respondent to complete the questions quickly, but have the disadvantage of creating a pattern of filling in the same numbers for each question (Cohen et al., 2011, p. 393). The question below represents a Matrix Questioning example used in this study:

Which of the following would best describe a reason for an individual being stranded and requiring an emergency rescue in your adventure sport.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Inadequate search and rescue technology	⭘	⭘	⭘	⭘	⭘

4.2.6 Check that each issue has been addressed

This stage in the questionnaire development process ensured that all aspects had been covered and that well-considered decisions and questionnaire items had been constructed. Giesen et al. (2012) suggests that a check list be constructed in which the researcher can evaluate general questionnaire items, phrasing of the questions, questionnaire response options, instructions, questionnaire structure and finally items relating to internet questionnaires. A checklist of items proved valuable as once all items had been checked off the questionnaire was ready to be piloted.

4.2.7 Pilot the questionnaire and refine items as a consequence

The piloting of the questionnaire in this study was of paramount importance, as it increased the validity and reliability of the study and ensured that all errors and problems were rectified before the questionnaire was rolled out. Piloting the questionnaire discovered

typographical errors as well as ambiguity in the question wording and jargon. Technical errors were also discovered such as the web page refreshing unnecessarily which frustrated the users. Feedback received by the pilot participants was taken into consideration and implemented into the questionnaire to produce a new refined questionnaire which can be viewed in Appendix A. (Oppenheim, 1992, p. 48) states that everything with regards to a questionnaire should be piloted and nothing should be left to chance.

The questionnaire was piloted by river and ocean kayakers in the Eastern Cape area of South Africa. The participants were selected based on their competency in the adventure sport and involvement in the kayaking industry.

4.2.8   Administer the final questionnaire

Cohen et al. (2011) identify that questionnaires can be administered in a variety of ways including self-administration, post, face to face interviews, telephonically and via the internet. The questionnaire in this study used the internet as a means of distribution. Internet administration was selected as it could reach a greater population, and although creating a custom made online questionnaire was time consuming, gathering the results after the questionnaire deadline was rapid.

An online questionnaire was designed using ASP.Net with HTML as the front-end development, C# as the programming language and Microsoft SQL as the database to capture the participants data selections. A custom designed online questionnaire was created to overcome limitations experienced with using 3rd party survey solutions. Upon the completion of the questionnaire, it was transferred from the local development environment to an online space via a file transfer protocol application (FTP) named FileZilla. Figure 4.8 displays the live environment detailing the local environment and the web server where the online questionnaire resided.
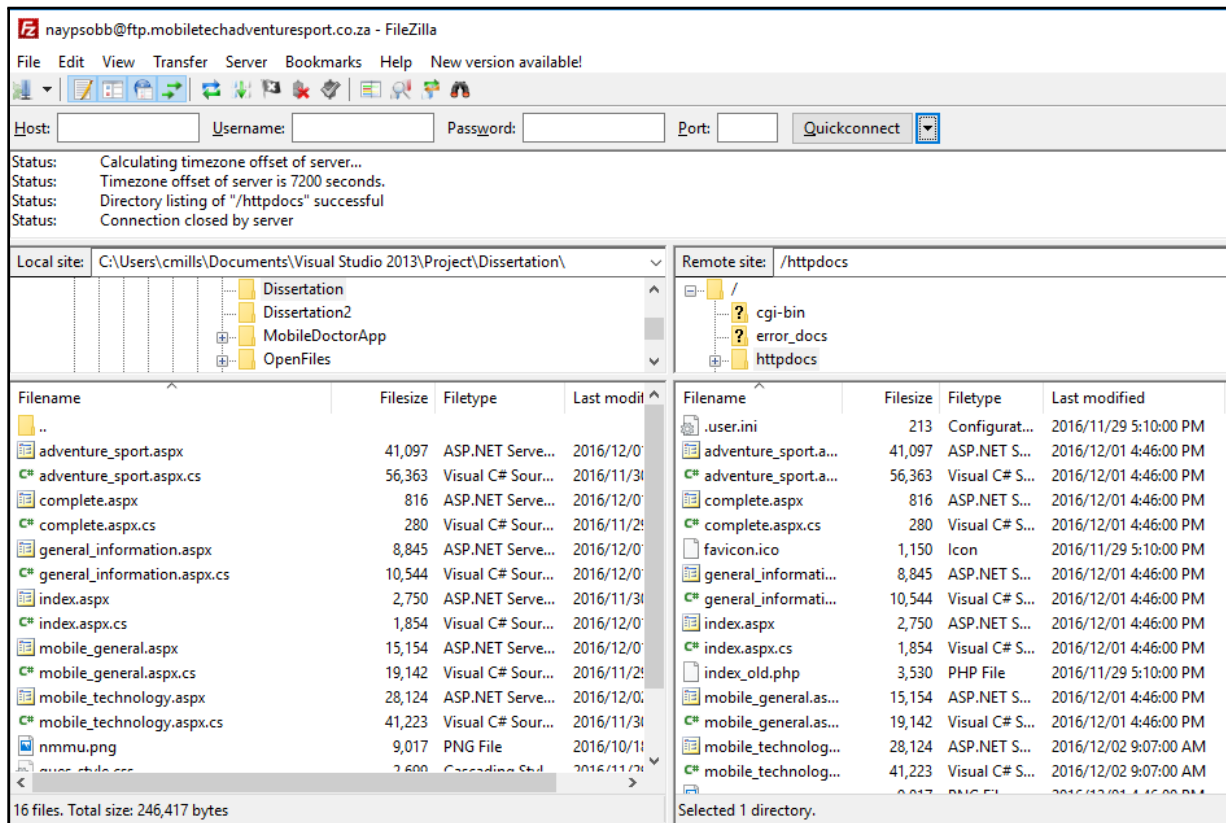
Figure 4.8: FTP Server for the Online Questionnaire

Each participant completed the questionnaire online which was made available at http://www.mobiletechadventuresport.co.za. This domain space was specifically created for the study and was decommissioned upon completion. Figure 4.9 provides an overview on how the various components were used in the questionnaire process. Special attention is made to the asynchronous arrows between the participant and the online questionnaire as information was provided to the online questionnaire and the participant. Only once the online questionnaire was completed was the information committed to the online SQL database.
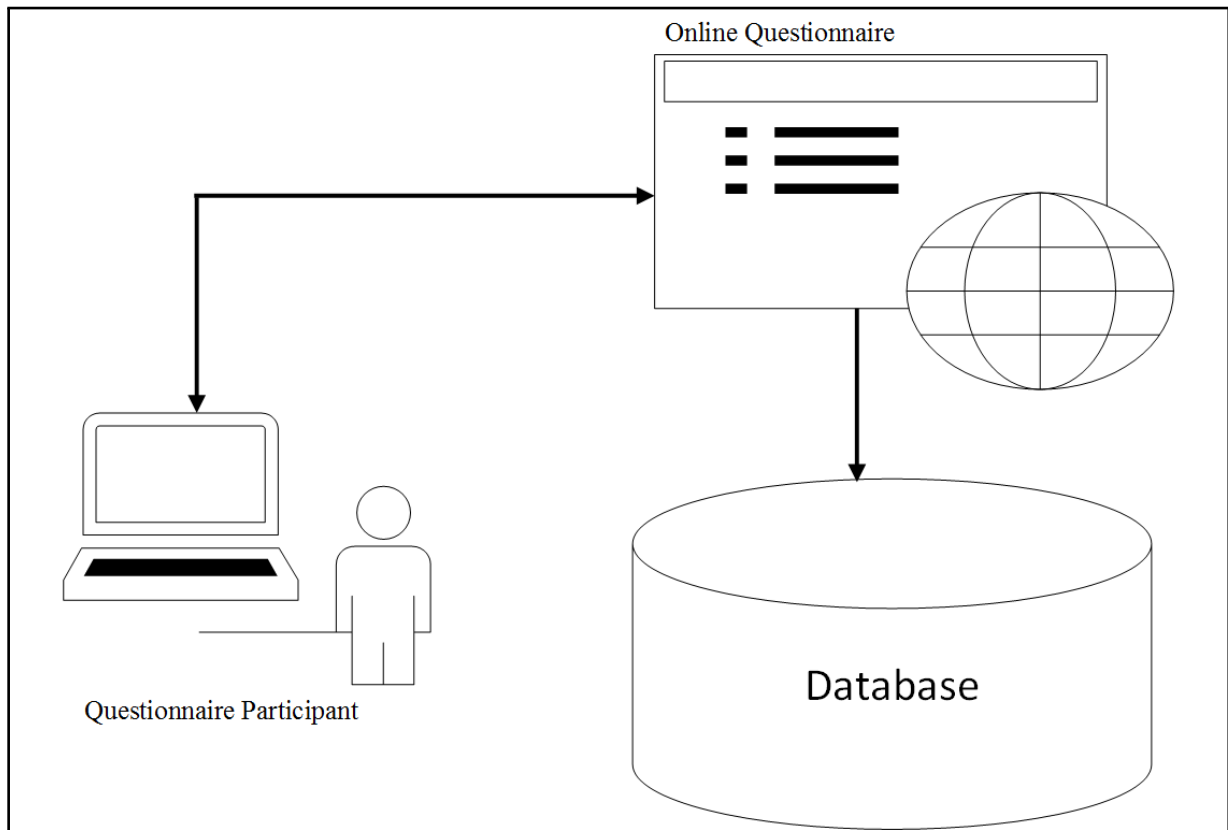
Figure 4.9: Questionnaire Process

4.3 Interpretation of Questionnaire Data

Research often concerns itself with two types of variables, namely independent and dependent variables. (Cohen et al., 2011, p. 606) identifies an independent variable as an input that causes an outcome or influences a response. A dependent variable can be considered as a response to an independent variable.

For example, in this study we may wish to determine if the implementation of mobile technology (independent variable) can assist in increasing the safety of adventure sport (dependent variable). Only once the independent and dependent variables were established could the data analysis focus on determining nominal, ordinal, discrete and continuous data types which is explained in Table 4.3.

Table 4.3: Data Type Variables

Nominal Data Variables	Nominal variables are most commonly associated with qualitative data. Data collected with this data type are organized into categories of equal importance (Wegner, 2000, p. 8). No mathematical equation can be applied to nominal variables as data can only be counted. Wegner (2000, p. 8) states that limited statistical analysis can be performed on nominal data types making it the weakest form of data.
Ordinal Data Variables	Ordinal data is also commonly associated with qualitative research, but differs from nominal variables in that order or ranking can be used to form categories. Mathematical operations on ordinal variables are inappropriate, as data is used for order purposes and numeric terms between categories cannot be expressed. (De Vaus, 2013, p. 204).
Discrete Data Variables	Quantitative variable that consist of integer (whole number) values. Therefore decimal or fractional values are not appropriate (Cohen et al., 2011, p. 608). An example of how to generate discrete data in this study is to ask a question such as: *How many mobile technology devices do you use during an adventure sport event?* Responses to this question could include values such as 1, 2, 3, which is acceptable. A response such as 1.75 would have been inappropriate.
Continuous Data Variables	Continuous variables are quantitative in nature and can take on any value in a certain range and can vary in quantity (Cohen et al., 2011, p. 608). Continuous variables are obtainable in this study from questions such as: *During an ocean kayaking event, approximately how many kilometres do you travel?* Responses to this question could include values such as 1.75 kilometres or 3 kilometres, which are acceptable continuous data responses.

The statistic findings produced by this study would only be valuable if they could be effectively communicated graphically. As the saying goes " *a picture is worth a thousand words*". Wegner (2000, p. 28) postulates that to convey statistical results effectively graphical techniques should be used.

The following graphical charts were implemented in this study to represent findings in a clear, concise manner.

Pie Chart: A chart that is circular in shape and is divided into sections or segments. The pie chart will be useful to represent the responses from the adventure sport participants as the size of each segment is proportional to the amount of responses. Pie charts are well suited to this study as Wegner (2000, p. 29) states that continuous data can represented using pie charts, but is more suited to categorical data (nominal and ordinal data types).

Bar Chart: These graphical charts will be used to represent data using horizontal (x-axis) and vertical axis (y-axis). The bar heights must have a total sum of 100 percent (Wegner, 2011, p. 31). Variations of the bar chart were also used in this study, including the stacked bar chart which will split the frequency of the column variable as a different means of presenting the data graphically.

4.4   Conclusion

This chapter assisted in identifying the scope and revealing the path that the research needed to pursue. The research methodology implemented in this study was discussed in detail, comprising of two literature reviews, creating and refining the questionnaire, analysing the questionnaire results and finally the creation of a framework. The research questions and objectives posed in Chapter 1 at this point are now aligned with the research methodology to provide valuable research work.

This chapter outlined the eight step sequence used to create an online questionnaire for the purpose of data collection in this study. A major deliverable from this chapter was the completed questionnaire, which was planned, piloted and administered. Additional work was done in this chapter which entailed the creation and coding of a custom questionnaire, and publishing it on an online space that was made available to all the questionnaire participants.

The following chapter deals with the analysis of the data obtained from the questionnaire submitted by the adventure sport community in the Eastern Cape province of South Africa.

Chapter 5

Adventure Sport Questionnaire

In much of society, research means to investigate something you do not know or understand.
- Neil Armstrong
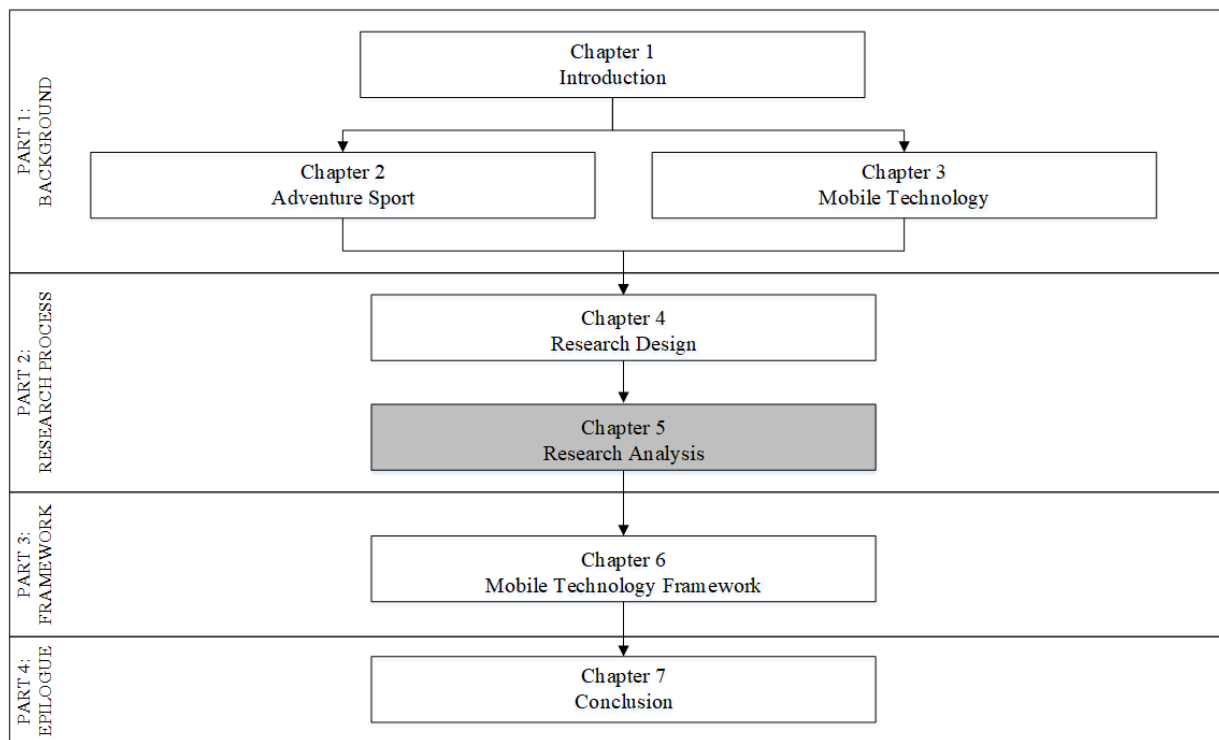
5.1 Introduction

Individuals who participate in any form of adventure sport eventually expose themselves to a variety of environmental variables, factors and possible isolation. As discussed in Chapter 2 there could be various reasons for an individual partaking in adventure sport that is dangerous and potentially life threatening.

This chapter attempts to address the research questions posed in Chapter 1. The chapter purpose is to discuss and present the findings of the online questionnaire by analysing each question with graphical representation of the responses. A representation of the online questionnaire, with questions and numbering can be viewed in Appendix A.

5.2 Online Questionnaire Overview

The evaluation of the questionnaire was divided in four sections, which represented the structure of the online questionnaire presented to the participants.

Table 5.1: Questionnaire Structure

Section Number	Section Title	Number of Questions
1	General Information	4 Questions
2	Adventure Sport	8 Questions
3	General Mobile Technology	9 Questions
4	Mobile Technology	7 Questions

Due to the nature of this study which comprised of various participants spread across the Eastern Cape province of South Africa, the researcher implemented an online questionnaire which was distributed to the participants. An online questionnaire allowed for geographical boundaries to be crossed in an attempt to reach as many participants as possible.

Ten paddling clubs were contacted in the Eastern Cape who distributed the questionnaire to their members via email distribution lists. The following list of clubs in the Eastern Cape, which is one of the five clubs in South Africa, was discovered during the literature review in Chapter 2.

- Border Canoe Club

- Blue Water Canoe Club

- Fish River Canoe Club

- Knysna Canoe Club

- Outeniqua Canoe Club

- Wild Duck Kayak Club

- Plett Paddling Club

- Rhodes University Canoe Club

- St. Francis Paddling Club

- Kowie Paddling Club

One issue that was experienced is that not all clubs have the same amount of members, and the individual club memberships change due to members either leaving the club or relocating to another town or country. In totality 102 participants participated in the questionnaire and the following is a discussion of the results.

5.3   Section 1 Analysis

Section 1 was the introduction section of the questionnaire and established the participants general information, such as age, gender, ethnic background and marital status. The goal of this section was to determine the demographic information of the participants.

The first question posed in Section 1 was for the participant to identify their gender. Responses indicate that 72 males and 30 females participated in the study. As identified in Chapter 5 by Wheaton (2004, p. 6) and confirmed by the findings of this study that males are more likely to participate in adventure sport and more specifically ocean and river kayaking. Findings identified that 71% of the respondents were male while 29% were females.
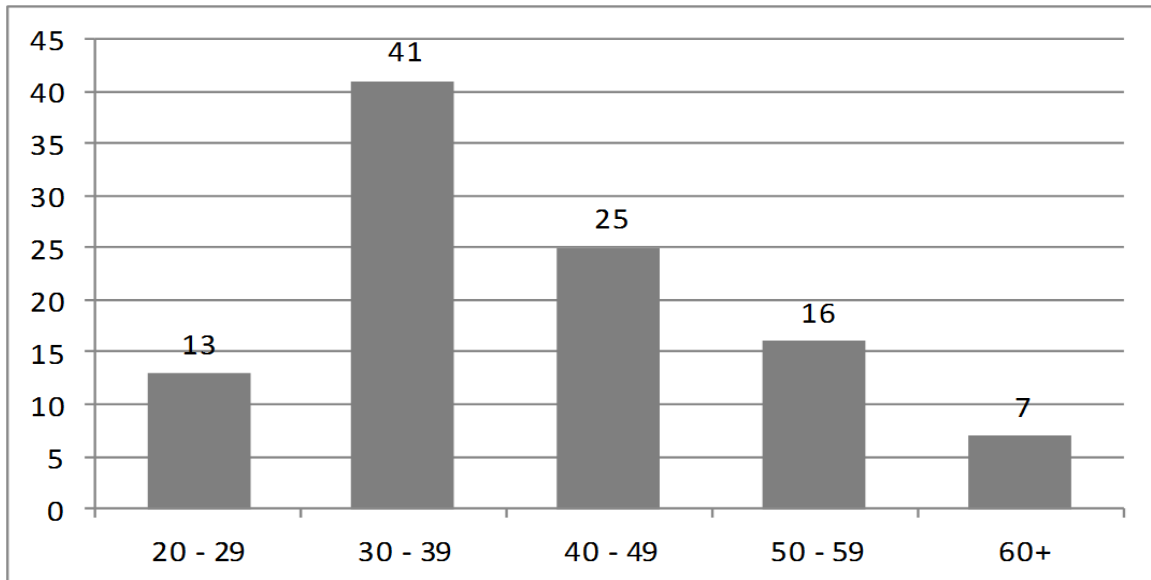
Figure 5.1: Participant Age Distribution

The second question in Section 1 required the participants to indicate what age category they belong to. One may assume that this type of adventure sport would only appeal to the youth, but data findings reveal a spread of ages with majority of the participants being between the ages of 30 and 60. Figure 5.1 outlines the age categories that participated in the study.

Next the questionnaire collected responses on the ethnic origin of the participants. Again reference is made to Wheaton (2004, p. 6) who states that adventure sport appeals to the white middle class of society. The research findings concur with this statement as 93% of the questionnaire participants were white, resulting in the other ethnic groups making up the remaining 7%. Another option was included for individuals who did not fall into the category of Asian, Black, Coloured and White, but this option was never selected in this study.

Finally the participants were requested to indicate their marital status. Figure 5.2 represents the responses displaying that the majority of the participants are married. The justification for this question is to determine whether being in a committed relationship increases the need for extra safety, which this study is attempting to provide in the form of mobile technology.
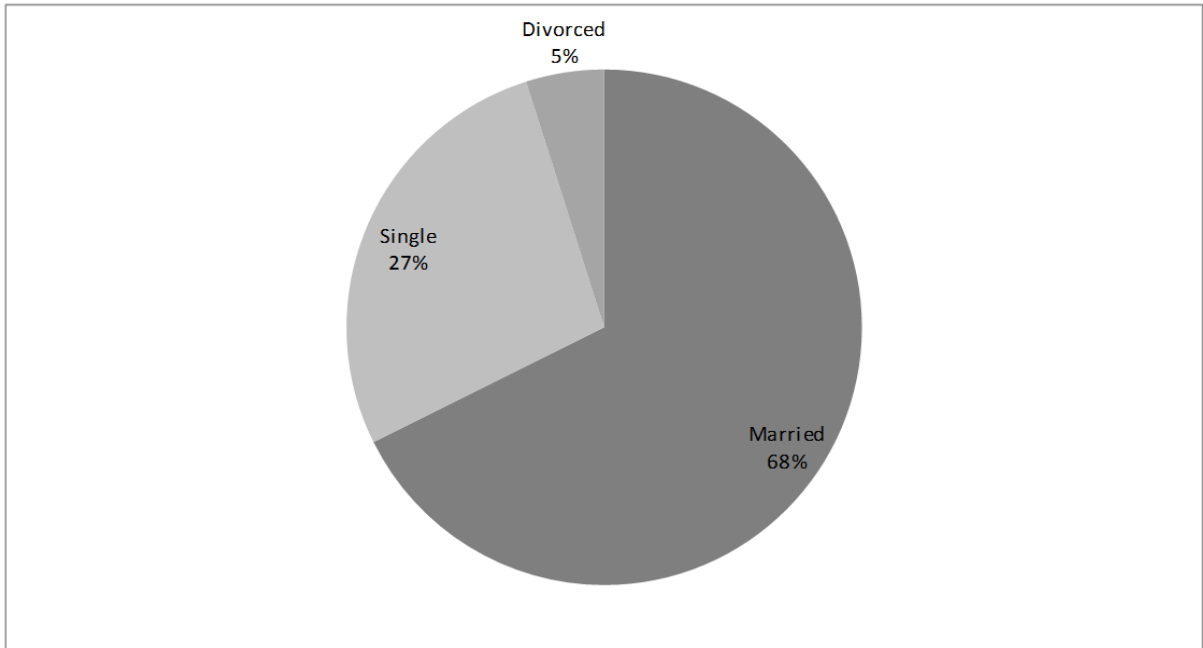
Figure 5.2: Participant Marital Status

5.4 Section 2 Analysis

Section 2 was designed to obtain general information about the adventure sport the participants are involved in. The main focus of the questions was on river and ocean kayaking, but information such as level of expertise, level of involvement and other adventure sport participation was also established.

Due to the fact that this study is based on ocean and river kayaking, it was fitting to establish which adventure sport the participants are primarily involved in. Interestingly enough 30% of participants were involved in both ocean and river kayaking, as the ocean form of the sport is considered more dangerous due to the additional environmental factors. Figure 5.3 visually displays the participants responses to the type of adventure sport they were involved in, indicating that 55% of the participants partake in river kayaking.
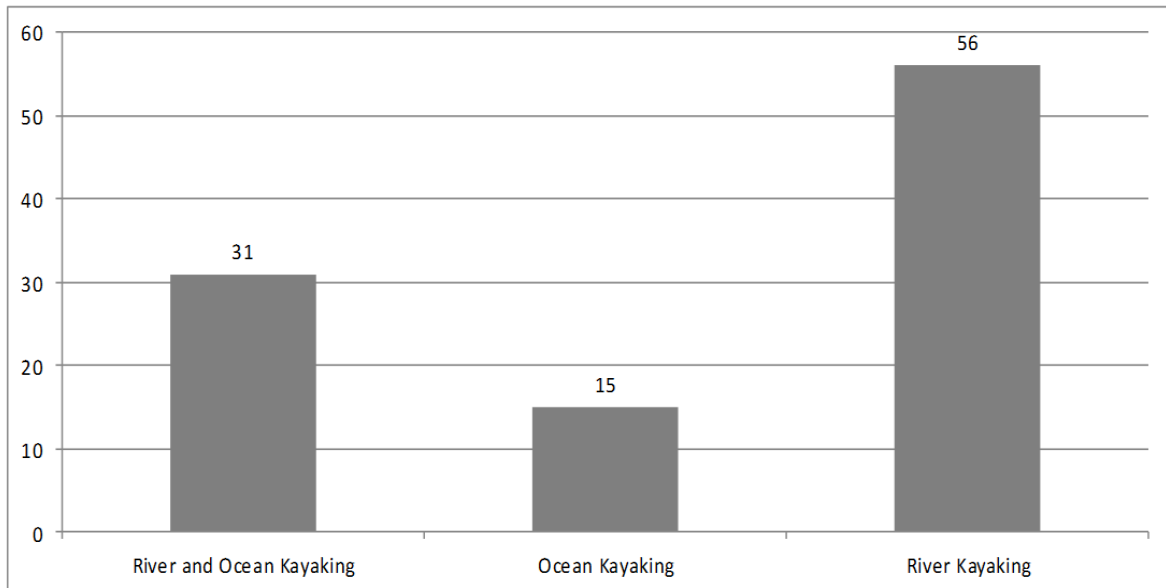
Figure 5.3: Participant Selected Adventure Sport

To determine the validity of the participants responses, Figure 5.4 represents the years of experience that the participants have in their chosen adventure sport. An interesting result is that all of the participants have more than one year experience, which ensures that the findings are from participants with a certain degree of experience. The majority of the participants fall into the 1 to 5 years experience range, but 27% of the participants have 20 years or more experience.
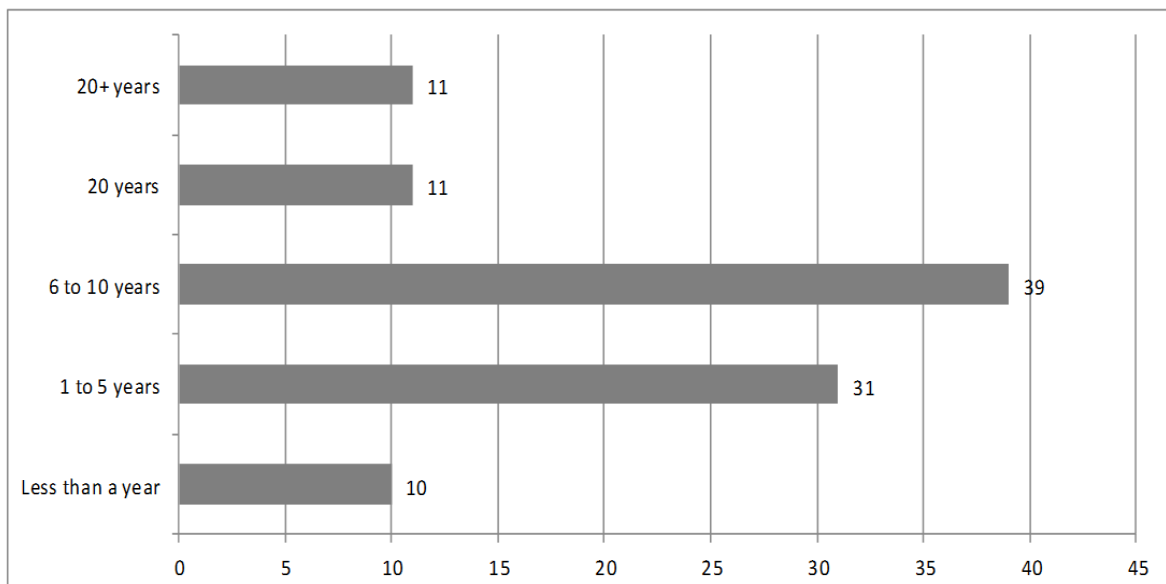
Figure 5.4: Participant Years of Experience

Participants of the questionnaire were predominately clubs members as identified by

Figure 5.5. This result could be from the fact that the main distribution of the online questionnaire was to ten paddling clubs in the Eastern Cape. A concern was that the responses might be biased in nature, therefore the questionnaire was designed to target recreational or social kayakers, club members and expert kayakers that have represented their province or country in events. This strategy proved effective as it targeted all levels of kayaking experience.
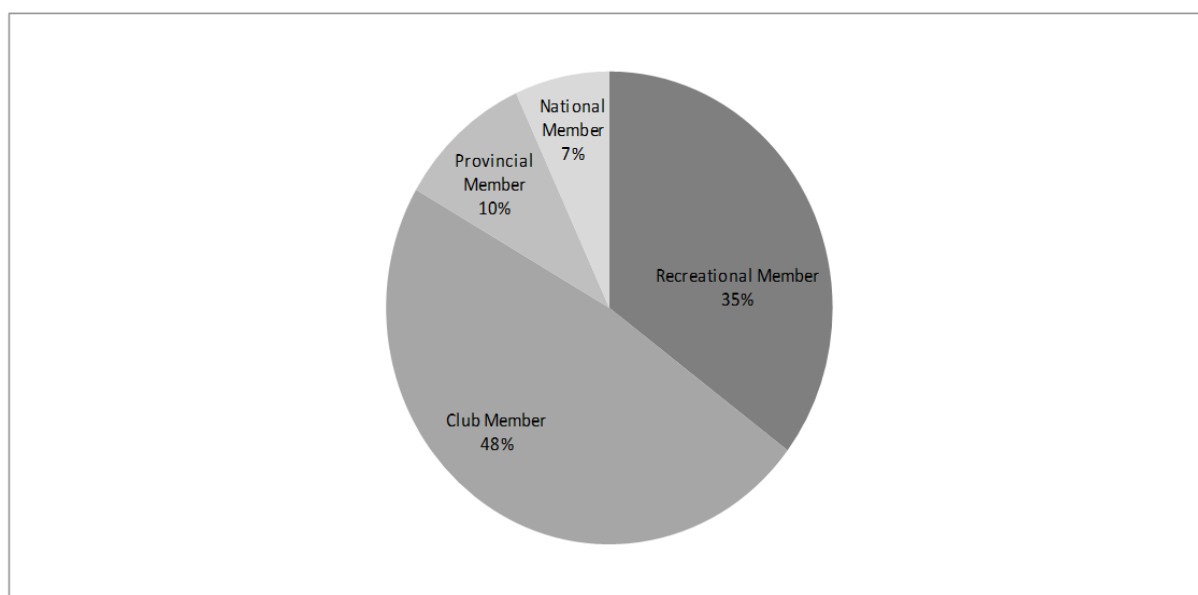
Figure 5.5: Participant Level of Involvement

Once the years of experience and level of involvement had been established the participants were then required to answer a dichotomous question on whether they have ever witnessed or been involved in a situation that left them or another individual stranded waiting for emergency response teams to assist. The validity of this question is important as it forms the basis for this study, as the research attempted to discover whether mobile technology could provide assistance in these situations. Participants responses indicate that 60% of the ocean and river kayaking community have witnessed or been involved in an emergency situation validating that dangerous situations do occur in this type of adventure sport and justifying the need for this study.

In an attempt to understand the reasons for an individual being stranded and requiring emergency assistance, the participants were requested to score on a Likert scale four possbile reasons discovered by the literature review in Chapter 2. The possible reasons included

Neglect of safety regulation, Reckless behaviour, Inexperience on behalf of the individual and finally *Inadequate search and rescue technology.*

The first three reasons received predictable responses with participants agreeing that neglecting of safety regulations, reckless behaviour and inexperience would result in an individual being stranded requiring emergency assistance. Inadequate search and rescue received a totally different representation which can be viewed in Figure 5.6. The majority of the responses agreed that there is inadequate mobile technology to assist in search and rescue operations. These results suggest that some kayakers are attempting to use mobile technology in their events, whereas others either have not heard of using mobile technology or have not considered using it. One might even argue that the paddlers use technology but cannot decide whether using mobile technology in their adventure sport is effective.
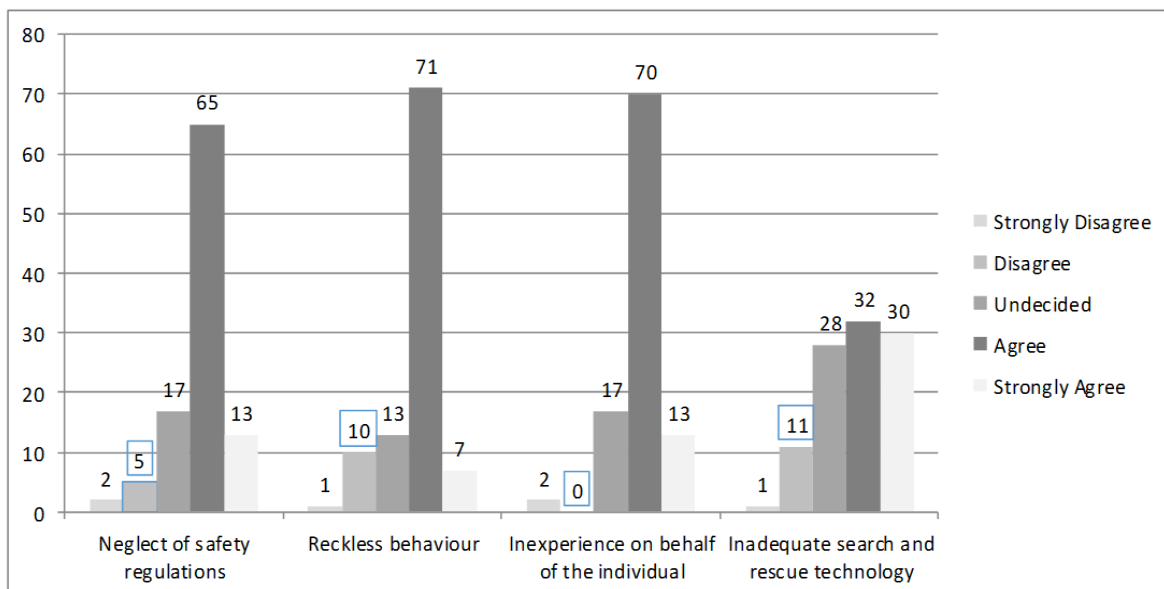
Figure 5.6: Participant Responses to Reasons for Emergency Situations

The participants were requested to indicate how many times a month they expose themselves to isolated environments. To obtain a result from all levels of experience, the participants had a selection of *once a month, less than four times a month, more than four times a month* and *other.* No participants selected the other option which was presented for extreme cases.

Figure 5.7 exhibits the responses which clearly indicate that majority of the participants expose themselves to isolated environments more than four times a month. This finding agrees with the statement made by Breivik (2010) who states that adventure sport participants are willing to take extreme risks to achieve adrenaline experiences. The responses

for less than once a month and less than four times a month indicate the kayakers that do not venture into remote locations such as the ocean and certain sections of rivers.
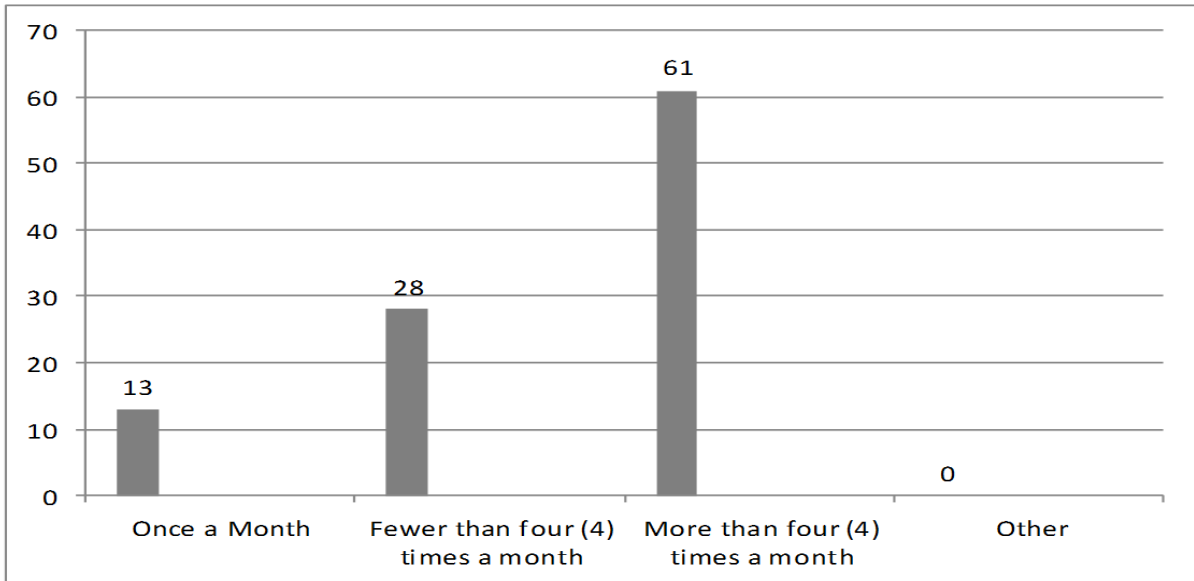
Figure 5.7: Participant Responses on Exposure to Isolated Environments

The next set of questions were designed in an attempt to understand what safety equipment the kayakers have with them during an event. The list of items were discovered during the literature review process and discussed in Chapter 2. The goal of these questions was to determine how frequently these items are used and why some form of mobile technology is not included in the list for emergency situations.

The participants were required to select how important each item is during their events on a scale from one to five, one indicating that the safety item is never used and five indicating it is always used. Figure 5.8 displays the mode responses of each safety item. The safety feature that all participants indicated as the most important is having at least 10 litres of boat buoyancy. Due to the fact that this sport relies on flotation devices it is understandable that the participants and event organizers consider this item important.

Thermal clothing, drinking systems and spray decks were considered the second most important as each item had a mode selection of 3. Thermal clothing and drinking systems are vitally important as these items could keep an individual alive until emergency response teams locate and rescue the stranded individual.

An alarming discovery was that kayaking jackets and polyethylene helmets ranked amongst the lowest safety equipment. Before the researcher conducted the online questionnaire it was assumed that these two items would be perceived as being the highest safety precautions. Instead the participants view these safety items as unnecessary. The

low response for a throw rope is understandable as not all emergency situations would require a rope.
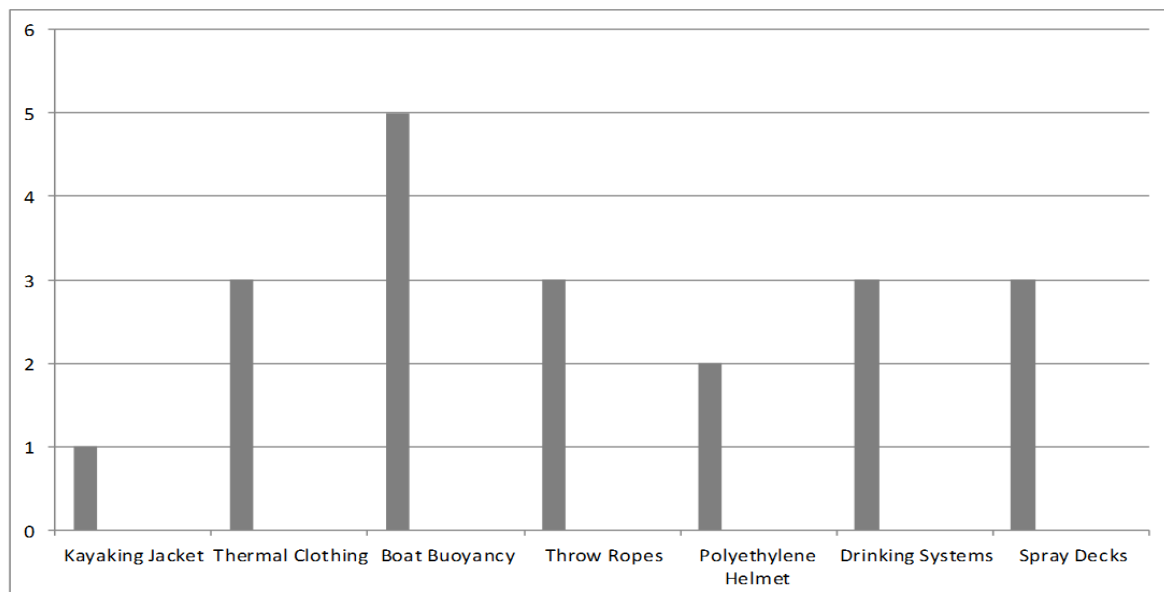
Figure 5.8: Participants Responses to Safety Equipment

The final question in Section 2 was to determine if the ocean and river kayakers also participate in any other form of adventure sport. The participants were presented with a list of eight common adventure sports to choose from, as identified in Chapter 2. The purpose of this question was to identify if other types of adventure sport appeal to a certain personality type, or whether an individual selects their adventure sport based on personal preferences.

It is evident from Figure 5.9 that the participants never or seldom partake in other forms of adventure sport. Hiking appears to be the only other type of adventure sport that the participants are involved in, but this is seldom. A reason for this could be that most adventure sport require specialized and expensive gear, resulting in adventure seekers only participating in one type of adventure sport.
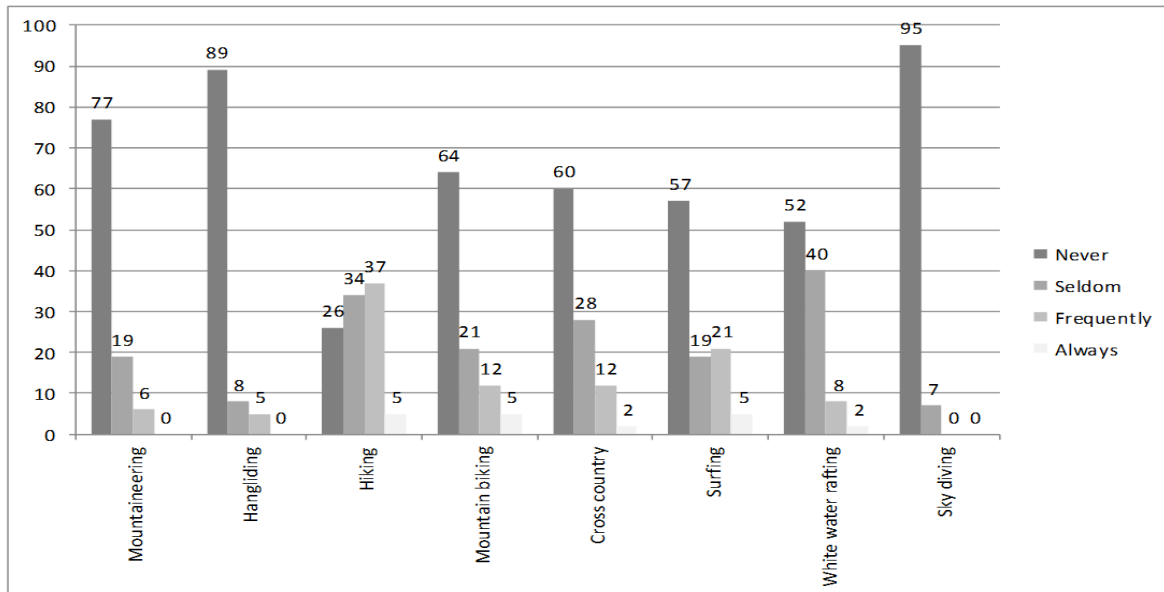
Figure 5.9: Other Forms of Adventure Sport Participants Partake in

5.5 Section 3 Analysis

This section of the online questionnaire was designed to obtain general information with regards to the following:

- Identify if mobile technology has previously assisted the participants in emergency situations.

- Establish the participants understanding of the importance mobile technology could provide in their adventure sport.

- Determine the willingness of the participants to use technology in their chosen adventure sport.

The first question that was posed to the participants was for them to indicate whether they would use mobile technology in their adventure sport. This question would prove to be vital as if the paddlers were not open to using mobile technology then the entire study would have to focus on not using mobile technology such as smart phones but rather hidden or embedded technology that the paddlers would not be aware of. These hidden or embedded devices could be for example GPS modules embedded in the kayak or kayaking jacket.

Figure 5.10 reveals that the participants would be open to using mobile technology in their events. The question did not specify a particular type of technology, but rather their

willingness to use mobile technology. The result reflects a positive outlook on the study as 85% of the respondents both agreed and strongly agreed to using mobile technology.
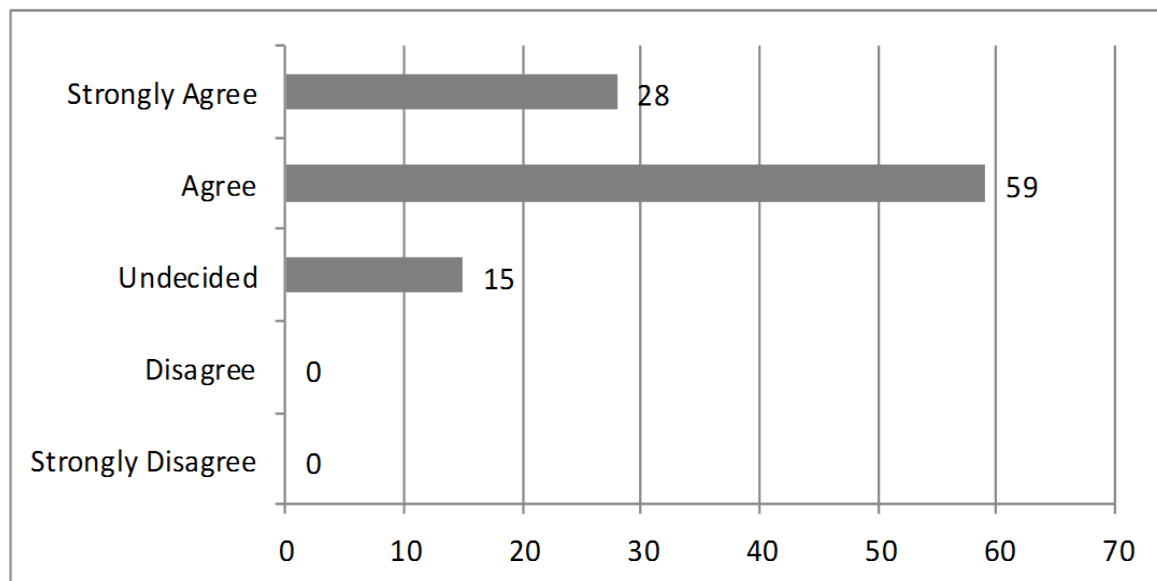
Figure 5.10: Participants willingness to use mobile technology in events

A major concern on the outset of this study was whether the ocean and river kayakers would perceive mobile technology as hampering their ability to perform in an event. Results prove that this is not the case, as can be viewed in Figure 5.11, with only 6 out of the 102 participants viewing that mobile technology would hamper their performance in events.
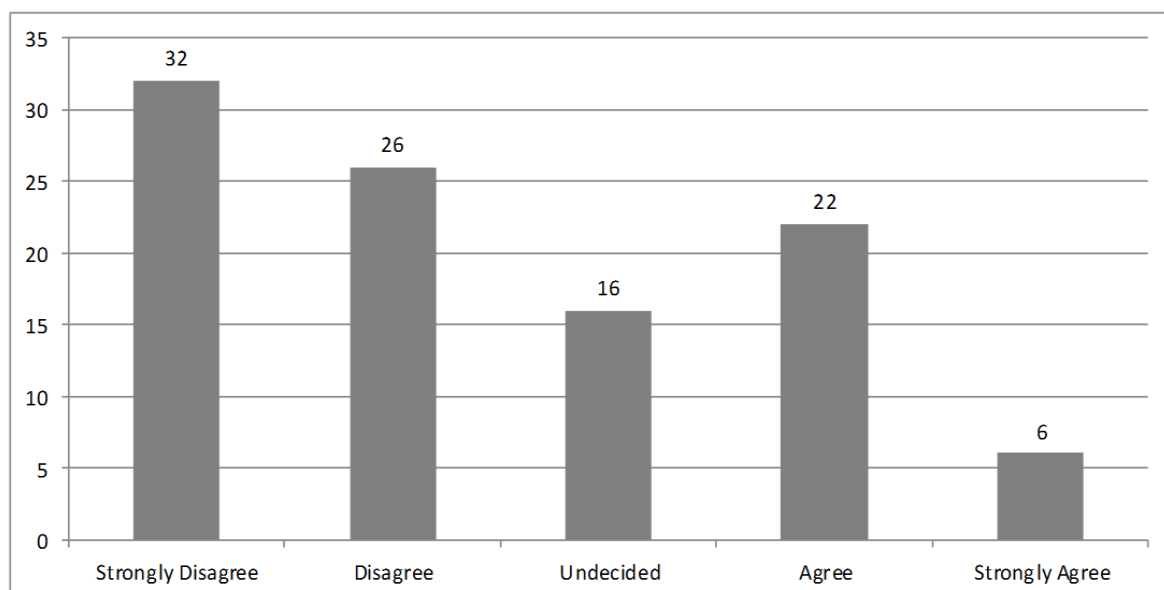
Figure 5.11: Responses to mobile technology hampering performance

The responses obtained from Figure 5.10 and Figure 5.11 demonstrate that the ocean and river kayaking community are positive about the integration of all forms of mobile technology into the sport to assist in improving safety without impacting performance in any way.

In an attempt to determine the mindset of event organizers and local clubs towards mobile technology, the participants were requested to respond to whether mobile technology is encouraged in events. Findings reveal a very positive result with no participants selecting that their clubs or events organizers do not strive for the use of mobile technology in events. Figure 5.12 clearly reflects the positive attitude of event organizers towards the adoptions and integration of mobile technology into ocean and river kayaking.
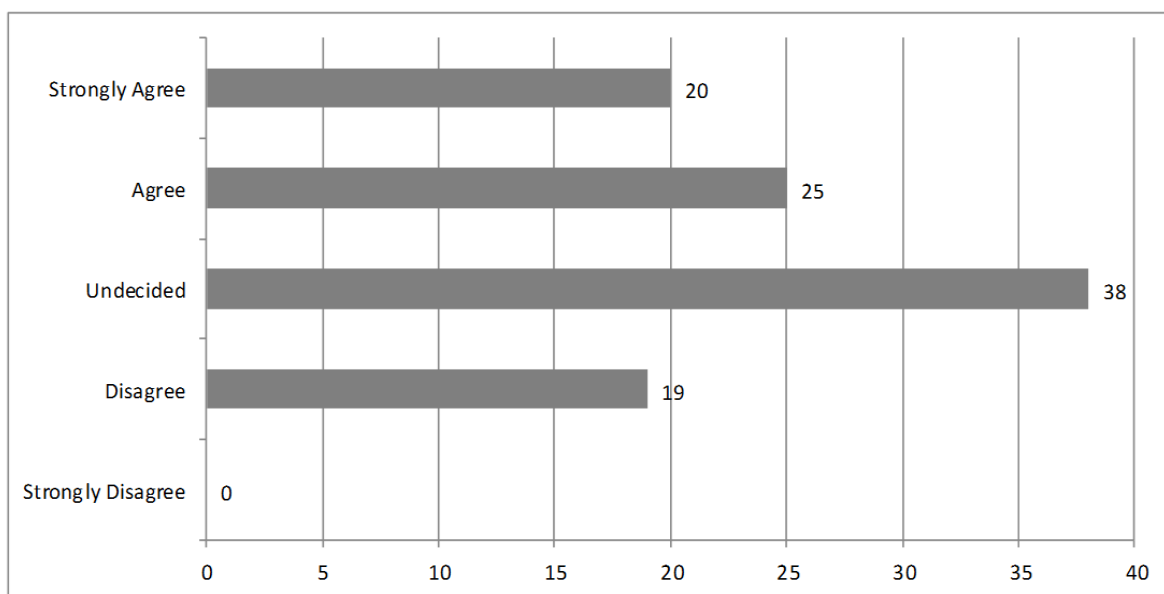
Figure 5.12: Participants willingness to purchase a mobile technology device

Figure 5.10 revealed that the kayaking community in the Eastern Cape is open to the idea of using mobile technology in their selected adventure sport. Based on that, the next two questions asked the participants to state whether they would purchase a mobile device or smartphone application to improve safety. The goal of these questions was to determine whether the participants take their safety seriously enough to purchase specialized mobile technology or applications to improve the safety of their events. Figure 5.12 and Table 5.2 identifies that a vast majority of the participants are willing to purchase either mobile technology or a smartphone application to assist in the safety of the sport. It must be stated that no cost of either the mobile technology device or application was discussed in the questions, which could have altered the results.

Table 5.2: Responses to purchasing a smart phone application

Question Options	Responses
Strongly Disagree	0
Disagree	2
Undecided	19
Agree	55
Strongly Agree	26

The questionnaire then requested the participants to indicate if they have ever witnessed or heard of a situation in which mobile technology assisted in the search and rescue of a stranded individual. The question in no way attempted to determine if mobile technology was used effectively in search and rescue operations, but rather to establish the awareness of mobile technology in the sport. Figure 5.13 identifies that the ocean and river kayaking community have heard of or witnessed mobile technology being used in search and rescue operations. This question reinforces the findings of the literature review in Chapter 3 which discovered current mobile technology and newspaper articles and discussed the use thereof. This finding proved to be critical in the development of a framework which is discussed in the next chapter.
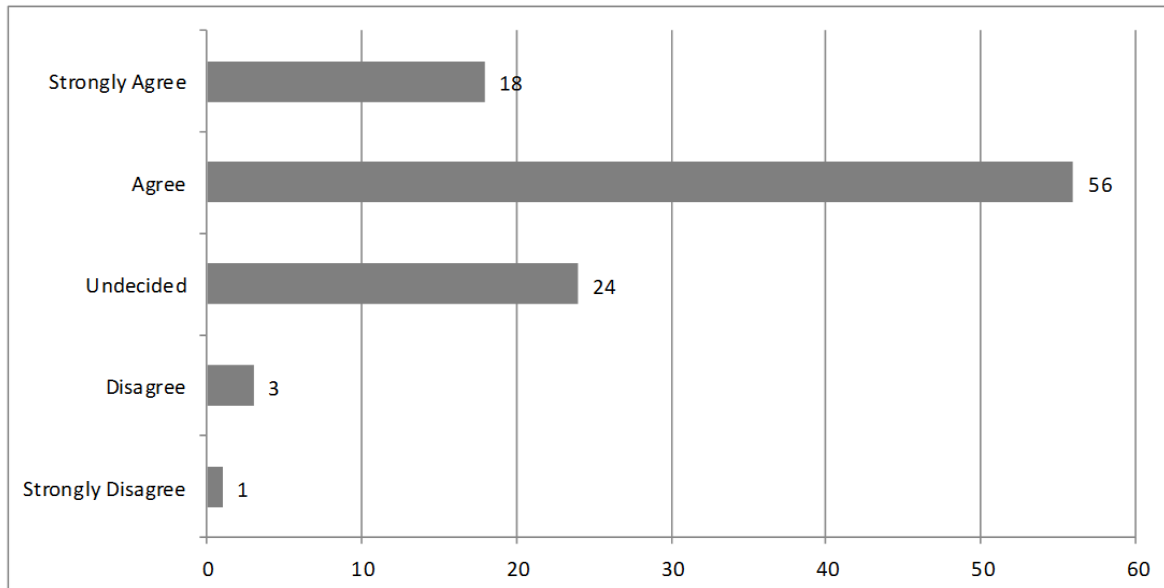
Figure 5.13: Awareness of mobile technology in ocean and river kayaking

The next question posed to the participants was whether they would like their loved ones to keep track of their location during an event. This issue is especially pertinent in situations when an individual is partaking in river and ocean kayaking by themselves. The

majority of the participants selected that they would like their loved ones to be able to monitor their locations in the event of an emergency situation occurring. The findings provide a positive outlook on the power that mobile technology can hold in assisting in emergency situations, and therefore validating the goals of this study.

The final question in Section 3 was to determine whether the participants perceive that emergency response teams use mobile technology effectively in search and rescue operations. The majority of the participants selected that they are unsure on whether it is used effectively, with 53 out of 102 participants stating they are unsure as can be viewed in Table 5.3. This finding is alarming as the paddling community should be aware of the efforts that are made by emergency response teams and the technology they use. The next highest selection with 29 out of 102 was that the participants agree that emergency response teams in fact use technology effectively.

Table 5.3: How Search and Rescue Operations are Viewed as Effective

Question Options	Responses
Strongly Disagree	0
Disagree	4
Undecided	53
Agree	29
Strongly Agree	16

5.6   Section 4 Analysis

Section four was the final set of questions in the online questionnaire. These questions focused on all the information technology aspects of the participants, with regards to the mobile devices they use, mobile operating systems, preferred mobile technology and the aspects of mobile technology that would not be suited to their adventure sport.

The first question presented to the participants in Section Four was to determine what the individuals predominately use their mobile devices for? The responses to what the participants use their smartphones for are displayed in Table 5.4.

Table 5.4: Participant Mobile Device Usage

Section Number	Never	Seldom	Frequently	Always
Social Media	7%	19%	40%	34%
Making Calls	14%	21%	42%	24%
Playing Music / Watching Movies	14%	21%	42%	24%
Taking Photos	0%	11%	43%	46%
GPS	1%	20%	50%	29%
Fitness Tracking	16%	37%	41%	6%

As can be seen from Table 5.4 the river and ocean kayaking community frequently use there smart devices for social media. Participants were not required to specify which social media they use as that would not form part of the study, but would have included social media such as Facebook, Intagram, Whatsapp and more.

The participants responded that they always use their devices to make calls, indicating that most of the participants are in a position to own the device and pay for calls. This is validated by (Wheaton, 2004) [p. 6] who states that individuals who participate in adventure sport aspire all the postmodern consumer culture in which owning a smartphone is important. The participants again were not required to specify the nature of the phone calls which could have been social or business related. Twenty one percent of the respondents stated that they seldom use their mobile devices for playing music and watching movies. If the frequently and always responses are combined, then 64% of the respondents use the devices to play music and watch movies, which is a valid response as most individuals prefer to listen to music during their training sessions.

Responses indicate that majority of the individuals, use their devices for taking photos, indicating that there is a certain level of proficiency when using their mobile technology. Combining the frequently and always responses indicate 89% use their devices for taking photos. Next the participants were requested to select if they use the GPS technology available with most mobile devices. A very positive outlook is that only 1% of the participants selected that they never use GPS technology. As identified in Chapter 3 Section 3.3.6, GPS technology would be extremely beneficial in search and rescue operations and therefore by the respondents selecting that they use the technology lays a strong foundation for the creation a framework which is discussed in the next chapter.

The positive responses that the participants use GPS technology is immediately followed by a negative result in that 37% of the river and ocean kayaking community in the Eastern Cape do not use their mobile devices for fitness tracking. This is a concern as the technology that is used to monitor individuals in search and rescue operations have many of the similar traits as with fitness tracking.

In an attempt to determine which type of technology would best suit the participants in their events, Question 4.2 required the participants to select what they perceive as being the best fit for their sporting events. Upon the completion of the literature review in Chapter 3 Section 3.3.6, smart phones with tracking application, standalone hand-held GPS device, GPS sensors and wearable devices were identified as the most relevant technologies. Data findings displayed in Figure 5.14 show that 37% of the participants would prefer an application on their smart devices. This finding is understandable as Figure 5.12 displayed that 81 out of 102 participants strongly agree or agree to purchasing a device to use the technology in events. A smart phone tracking application would be the cheapest option as most of the individuals would own a device and would not have to purchase any other forms of technology which could be expensive.
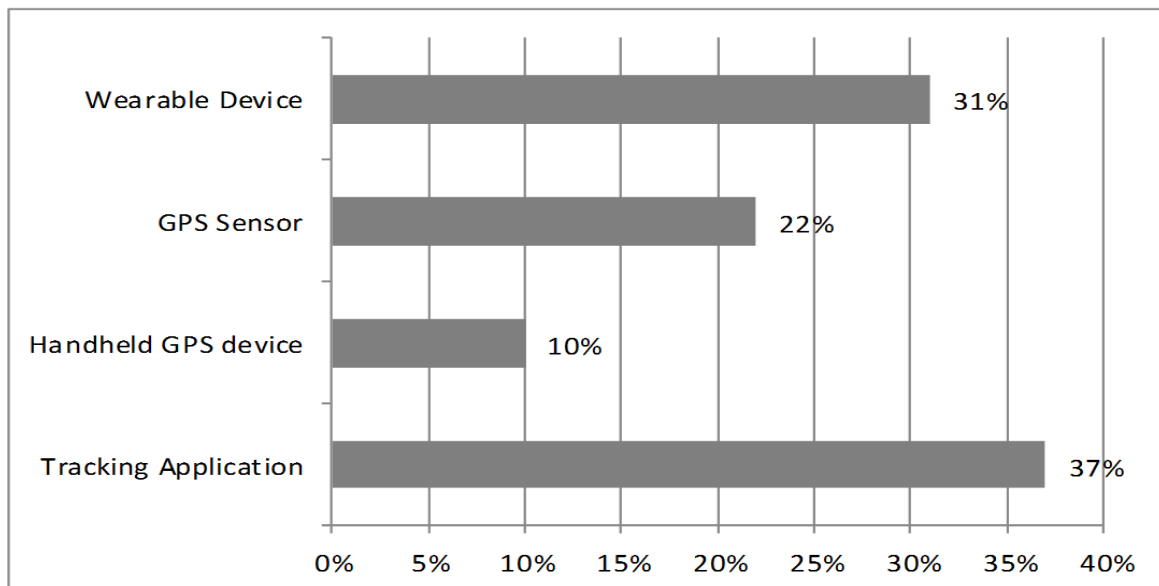
Figure 5.14: Technology Best Suited for Ocean and River Kayaking

Question 4.3 of the questionnaire survey was created to determine the mobile technology factors that the participants think would affect search and rescue operations in river and ocean kayaking. The factors that were identified are common issues that may be experienced with mobile technology, but as stated by (Eng, 2008) there are new developments in technology that are improving search and rescue operations with technology.

Table 5.5: Mobile Technology Factors Affecting Search and Rescue

	Strongly Disagree	Disagree	Undecided	Agree
Battery life	0%	3%	2%	95%
Signal strength	2%	0%	2%	96%
Device not waterproof	2%	7%	18%	74%
Loss of device during an event	1%	13%	31%	55%
Theft of device during an event	10%	37%	29%	24%
Lack of technical knowledge	2%	24%	45%	29%

As can be seen from Table 5.5 the participants do view the battery life of the mobile devices as a concern. The advancements in smart devices and other forms of mobile technology has extended the battery life, but if an individual is stranded in an isolated environment with no means to charge the device, the battery will run flat. Another valid concern is the technology that is used to constantly monitor an individuals smart phone, for example, requires a lot of battery processing.

There are ways to improve this for example by creating services that run in the background of the operating system resulting in less power usage. Lee (2012)[p. 429] validates the use of services and geographical coordinates by stating that a service requires no input from the user once started and runs in the background of an operating system.

The signal strength required by all mobile technology devices could pose the biggest challenge in monitoring an individuals location. This sentiment is shared by the participants as 96% view this as a valid factor that would affect search and rescue operations. Issues such as cell phone tower reception, data access via technology such as 3g or 4g, and satellite communication would all be viewed as signal strength. This factor is vitally important as this type of adventure sport requires the individuals to venture into remote environments where mobile technology signal strength could be very limited.

The next three factors were not specifically related to information technology but more from an incident perspective, and included concerns around waterproofing a device and whether the device might be lost or stolen during an event. The concern of the mobile technology devices not being waterproof is shared by 74% of the participants. Recent developments into waterproofing devices have proved to be successful, such as waterproof casing that enclose the device without the threat of water damage. These waterproof casing also have the added benefit of being attached to a paddlers arm or worn around the neck and then embedded in a life jacket, resulting in an effective unobtrusive solution. Participants indicated that losing the device during an event is a valid factor as 55% strongly agreed

with this factor. Based on the results the highest percentage of the participants disagree that their device would be stolen during an event.

The final factor in Question 4.3 was to determine if the participants feel that the lack of technical knowledge may in fact inhibit search and rescue operations with mobile technology. The lack of technical knowledge could result in an anxiety known as Technophobia which according (Kotzé, Anderson, & Summerfield, 2016) relates to individuals who are unwilling or unable to cope with new technologies in a productive manner. The findings indicate that 29% of the participants agree that technical knowledge would affect search and rescue technologies on the part of the participants. Majority of the participants agreed with 45% of the responses indicating that there is a strong chance that lack of technical knowledge would result in an inhibiting factor.

The second last question of the online questionnaire required the participants to select their current mobile operating system. Based on the literature review findings in Chapter 3 Figure 3.3 highlights Android as the leader in the South African market at the time of this study. This finding is validated with the results of Question 4.4 as 51% of the participants own a device that is running the Android operating system. The second most selected mobile operating system was iOS, which appeared as the third most popular mobile operating system in South Africa. Based on the results, a smart phone application to assist in the search and rescue operations in adventure sport should be aimed at the Android and iOS mobile operating systems.
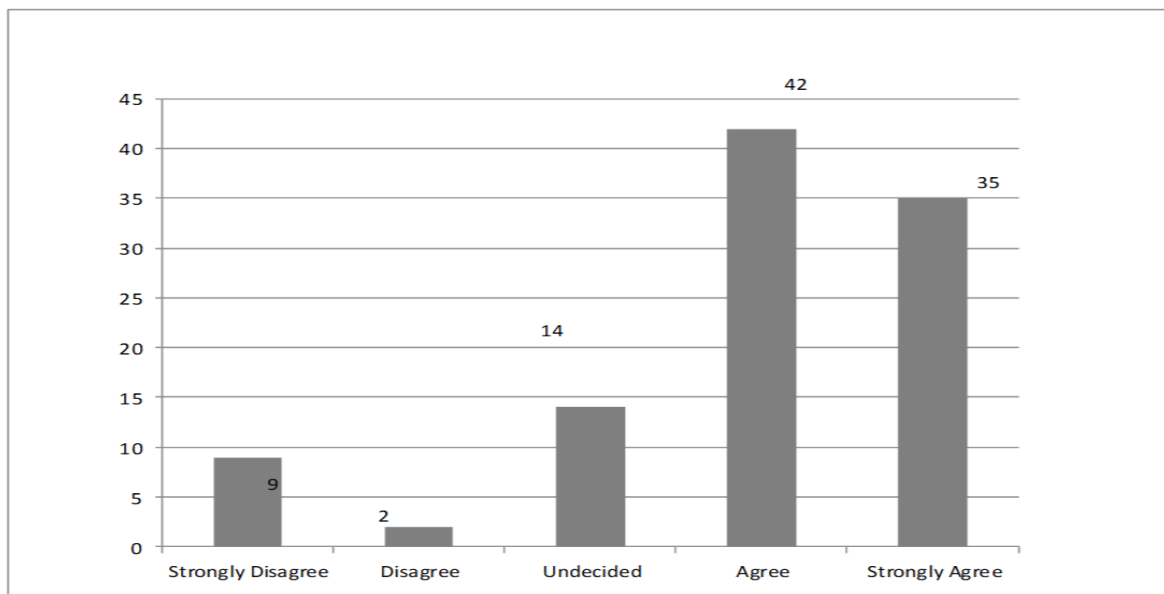

Figure 5.15: Participant Willingness to Change Device

Finally the results from Question 4.4 allowed a question to be posed to the participants

on whether they would change their smart phone to use an application for search and rescue operations. The participants were required to select their willingness to change devices on a Likert scale ranging from 1 to 5, where 1 represented (Strongly Disagree) and 5 represented (Strongly Agree). Figure 5.15 displays the willingness of the participants to change their devices. From the responses it is evident that the participants are open to the idea of changing their devices to assist in the safety of their adventure sport. Once again these results are based on the notion of switching the device and did not include factors such as the device price and personal preferences.

5.7   Conclusion

The findings in this chapter addressed the primary and secondary research problems posed in Chapter 1, which assisted in the creation of a framework presented in the following chapter. An online questionnaire was distributed to river and ocean kayakers in the Eastern Cape. The questionnaire consisted of four main sections with questions aimed at adventure sport and mobile technology. Ten prominent paddling clubs were contacted and asked to distribute the online questionnaire to the club members.

Volunteer and Snowballing sampling was used in the data analysis process and consisted of qualitatively explaining the findings and quantitatively presenting the results using various chart types and tables.

The following chapter focuses on the creation of a framework by drawing upon the findings produced by the literature reviews and data analysis chapters.

Chapter 6

Mobile Technology Framework

Creativity requires input, and that's what research is. You're gathering material with which to build. - Gene Luen Yang
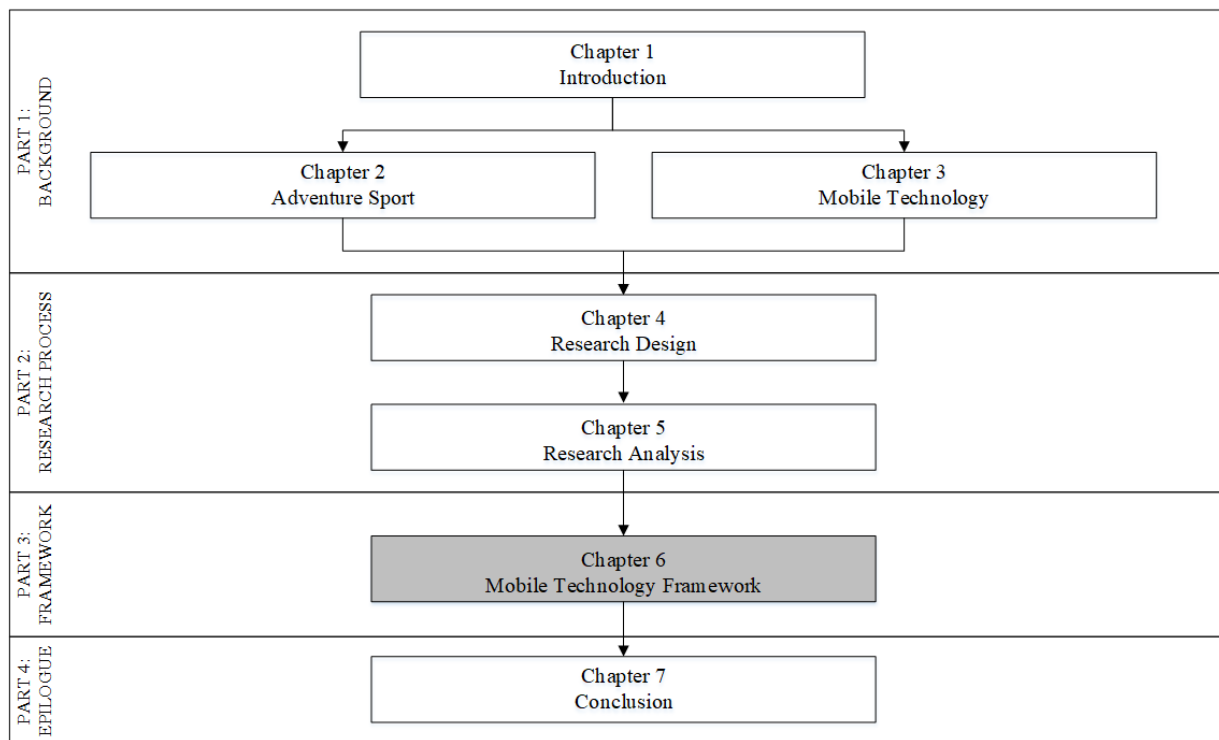
6.1   Introduction

Each ocean or river kayaking event has potential dangers associated with it. Whether it is an individual, social or competitive event, individuals are at risk of being stranded requiring emergency assistance. Previous chapters in this study have outlined the dangers as well as how mobile technology could assist in these situations. The specific mobile technology used during ocean and river kayaking events should be seamlessly integrated into the event without hampering performance.

Mobile technological aspects such as services, mobile applications, frameworks, mobile operating systems and SDK's, as outlined in Chapter 3, could all play an important role in designing a solution for the safety concerns with ocean and river kayaking. Such technology could provide event organizers and individuals with constant communication during events, and in the case of an emergency inform the necessary individuals and rescue teams. These mobile technology aspects could be incorporated into technological devices and software to provide event organizers and individuals with a safety framework relevant to South Africa and the international stage.

Non-Technological measures such as education could also play a vital role in improving the safety of ocean and river kayaking. Education with regards to how individuals and event organizers can effectively use hardware and software to improve the safety of this type of adventure sport. Adventure sports that are setting the trends with regards to incorporating mobile technology and education include snowboarding and mountaineering (McCann & Bryson, 2009, p. 39).

The purpose of this chapter is to produce an artefact, in the form of a theoretical framework, that will incorporate all the technological and non-technological aspects of ocean and river kayaking safety. This framework will attempt to address the primary research question, (as discussed in Chapter 1 Section 1.3) *How can mobile technology be integrated into adventure sport from a South African context, to assist in the safety of the participants?*

6.2   Theoretical Mobile Technology Framework

Presented in this Chapter is a **component-based framework** for adventure sport safety (as graphically depicted in Figure 6.1). The component-based framework depicts how the various components interact in an attempt to increase the safety of the sport. The main components of the framework include a human element, hardware, software and the events. The framework also depicts how the participants and event organizers (human element), interact with the hardware, software and event components. The triangular design suggests

that not one component is more imperative than another, but rather that each component has a shared importance.

This section discusses the mobile technology framework, which serves as a deliverable from this study. The framework components consist of a *Human Element*, *Hardware*, *Software* and *Events* as separate concerns.

In computer terms a framework is a structure indicating components and how they interrelate with each other (TechTarget, 2017). Each of the framework components in this study play a major role in assisting in the safety of ocean and river kayaking. If one of these components fail, the entire framework could be in jeopardy.

The synergy between the framework components can be viewed in Figure 6.1.
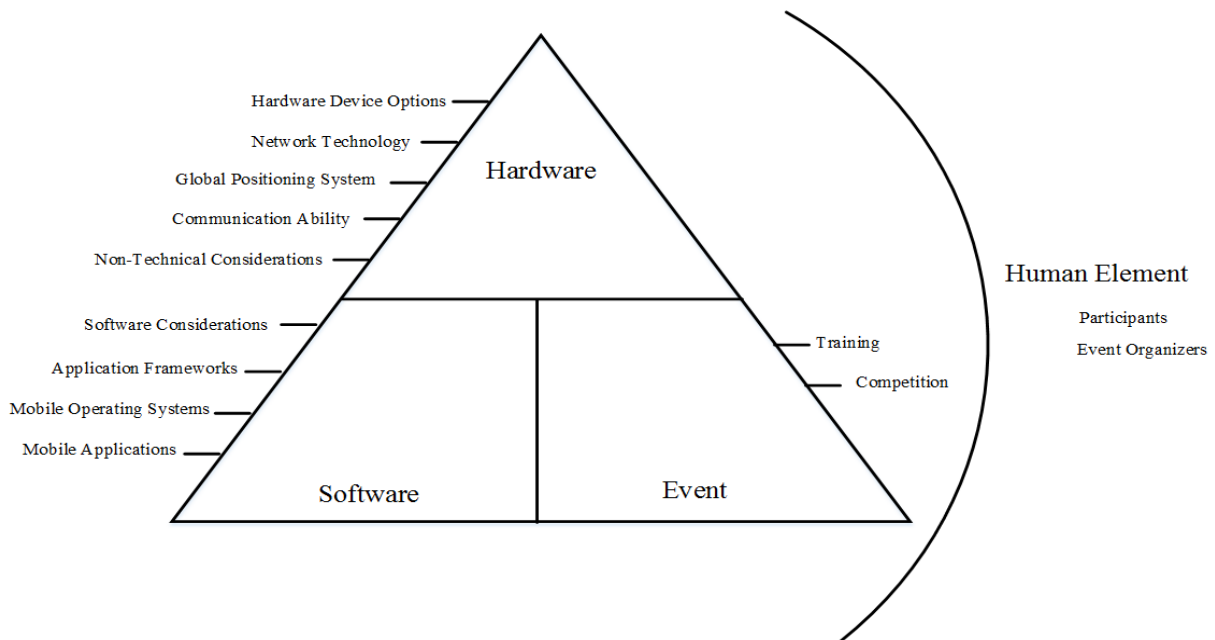
Figure 6.1: Theoretical Mobile Technology Framework

The framework components were identified during the literature reviews conducted in Chapter 2 and Chapter 3. The identified components were validated with the findings in Chapter 5 which discussed the results of the online questionnaire. Each component is addressed independently, but can influence the other components in the framework. For example, a new hardware device may be created which then requires software to be designed. Another view point is the human element may discover new hardware or software technologies to be implemented into events to increase safety. It was deemed necessary to separate the human element in the framework design as this component is responsible to

use hardware and software adequately in events to assist in the safety of the sport. The framework should be a living artefact not restricted to any order, thus the triangular design. The use of a triangular design does not force any hierarchy or sequence, but rather allows each component to be called upon when required. To provide more clarity on the logic of the framework components, the following possible scenario has been constructed:

An adventure sport participant may own a smart phone which is primarily used for making phone calls, social media or work purposes. Without the individual knowing, the smart device is an adequate tracking tool that could be used in ocean and river kayaking competitions or during training sessions. The human element could either download tracking software, or rather take an informed decision to purchase another mobile device dedicated to tracking purposes, such as the SPOT GEN 3 (as discussed in Chapter 3 Section 3.4.1.2).

Table 6.1: Theoretical Framework Components

Component	Description
Human Element	This consists of adventure sport participants and the event organizers. Participants need to have the correct mobile technology hardware and software for the events they participate in. Event organizers are responsible for enforcing some form of mobile technology into all events to promote safety.
Hardware	The hardware component of the framework consists of identifying literature suggestions in the form of mobile technology hardware that can be used to increase participant safety. Suggestions from the ocean and river kayaking community are also taken into consideration as these individuals will actually be applying these technologies in their events.
Software	The software component of the framework consists of identifying literature suggestions in the form of mobile technology software that can be used to increase participant safety. Software suggestions from the ocean and river kayaking community are also taken into consideration as these individuals will be downloading the applications onto smart devices and using them in events.
Events	Two main types of events have been identified in this study, that being competitive and training events. These types of events have been classified as each present their own set of dangers associated with this adventure sport.

The suggested theoretical framework relies on the role players associated with each component, that being the human element consisting of adventure sport participants, event

organizers and the hardware and software used in events to implement safety measures. Table 6.1 provides an overview of each role player's responsibility with regards to the framework implementation.

The following sub-sections constitute an in-depth discussion on how the various framework components could assist in increasing the safety of ocean and river kayaking.

6.2.1 Human Element

The first component in the framework to be discussed is the human element consisting of participants and event organizers. Findings obtained from Chapter 5 Section 5.3 revealed that the human element is comprised of 71% males and 27% females with the majoity falling in the 30 to 39 age range. Although it can be viewed that there was also an even spread amongst the other age groups as visually depicted in Chapter 5 Figure 5.1. The dominant ethnic group identied was white consisting of 93% and 68% in a full time committed marital relationship as displayed in Figure 5.2.

The human element is positioned outside of the triangular design as can be view in Figure 6.1. The reason for the separation is due to the fact that the human element is required to effectively use the framework triangulation of mobile technology hardware and software to increase the safety of their events.

6.2.1.1 Participants

The participants are the individuals that are exposed to the dangerous environmental factors associated with this type of adventure sport. Therefore it is essential that the participants be informed on the various mobile technology hardware, and mobile technology software that could assist in the safety of their beloved sport. Chapter 5 Figure 5.4 identified that only 9% of the participants of the online questionnaire had under a years' experience, with 48% affiliated as club members. Therefore the ocean and river kayaking community in the Eastern Cape province of South Africa would be in a good position to determine if mobile technology could assist in improving the safety of the sport.

The participants also have self-education at their disposal, which starts with sources such as the Internet, Sporting Technology Magazines and Journal Articles written on improving the safety of adventure sport with mobile technology. It is important for participants of adventure sport to gain as much knowledge as possible on the various mobile hardware and software options available to them. Each mobile technology option, whether hardware or software, possess their own strength and weaknesses with regards to assisting in the safety of adventure sport. It is the participants responsibility to learn how the hardware and/or software operates to insure the correct, timeliness use of the safety option in an

emergency situation. In an emergency situation this could mean the difference between life and death. Chapter 5 Figure 5.10 identified that the participants have a positive attitude towards using mobile technology by identifying how it can be used to increase safety.

The following are possible scenarios that a participant might experience with the inadequate use of mobile technology in an event:

- *The participant may be practising for an event and venture onto a body of water alone without a tracking device.*

- *During an event a participant may not have included a tracking device as part of their safety equipment.*

- *During an event a participant may not have fully charged the tracking device.*

- *During an event a participant may not have correctly identified how to use the tracking device in an emergency situation.*

- *During an event a participant may not have placed the tracking device in a secure position, resulting in the device being lost.*

The next section in the human element refers to the Event Organizers and the role these individuals play in the theoretical framework.

6.2.1.2 Event Organizers

The second component in the human element of the framework, is for event organizers to discover mobile hardware and software for participant safety. Event organizers should enlighten themselves and the participants on the dangers they may face during an event, with possible references to emergency situations for example the deaths of the two kayakers in South Africa (as discussed in Chapter 2 Section 2.5). Chapter 5 Figure 5.6 highlights the participant's reasons for emergency situations occuring, which Event Organizers must be familiar with.

The event organizers play a vital role in the suggested framework of this study, as they determine the race routes and enforce what safety precautions and measures are required for the event. The human element of participants and the event organizers could have been combined into one component, but due to the importance of each entity understanding the importance of safety, it was deemed necessary to separate them into separate concerns. As with the participants education, event organizers can research the Internet, Sporting Technology Magazines and Journal Articles for knowledge creation. The event organizers have the ability to create awareness on their acquired mobile technology knowledge by holding

safety workshops, sourcing guest speakers and possibly getting the manufacturers of mobile hardware and software to conduct presentations. Event Organizers have the authority to firstly insist on the implementation of certain safety measures such as mobile technology and; secondly prevent those participants without mobile technology safety measures from competing or participating in an event.

Event organizers should also make the participants aware of the dangers that could be averted by implementing mobile hardware and software into events. This process may however be dependent on a participants experience in ocean and river kayaking and maturity level. Event organizers should determine which mobile technology would be best suited to assist in the safety of ocean and river kayaking, by first identifying the dangers that could present themselves to the participants during a competitive or training event. The following discussion are some awareness creating options available to event organizers as suggested by the researcher of this study, and are in no way albeit to.

Safety Workshops. Event organizers could hold safety workshops for the participants before an event. These safety workshops could introduce specific mobile hardware and software that should be used during an event to assist with search and rescue operations if required. Safety workshops could be held before events that are known to have clear and present dangers, or held as a local event for all levels of kayakers to attend to promote safety.

Guest Speakers. Guest Speakers may be an excellent manner in which to promote safety awareness and education. Guest speakers should be individuals who have stature and respect with the ocean and river kayaking community. These individuals could present either emergency situations they were in, or situations they witnessed in which mobile technology assisted in the search and rescue of stranded kayakers.

Vendor Presentations. This final suggestion on creating safety awareness with regards to mobile technology may prove to be the most challenging. Time constraints and geographical locations of the vendors, event organizers and participants could prove challenging in this regard. Event organizers could contact the manufacturers of the mobile hardware and software (as discussed in Chapter 3 Section 3.4.1 and Section 3.4.2), to present the technology and how it could be incorporated into the sport in an attempt to increase safety.

The suggested awareness creating options are just a few possible methods to promote mobile technology safety awareness among the participants of ocean and river kayaking. Ideally this communication should be a continuous communication between participants and event organizers. Once the participants are educated and informed to a suitable level, the event organizers will then need to perform a supervisor role to ensure that mobile technology is used effectively in events.
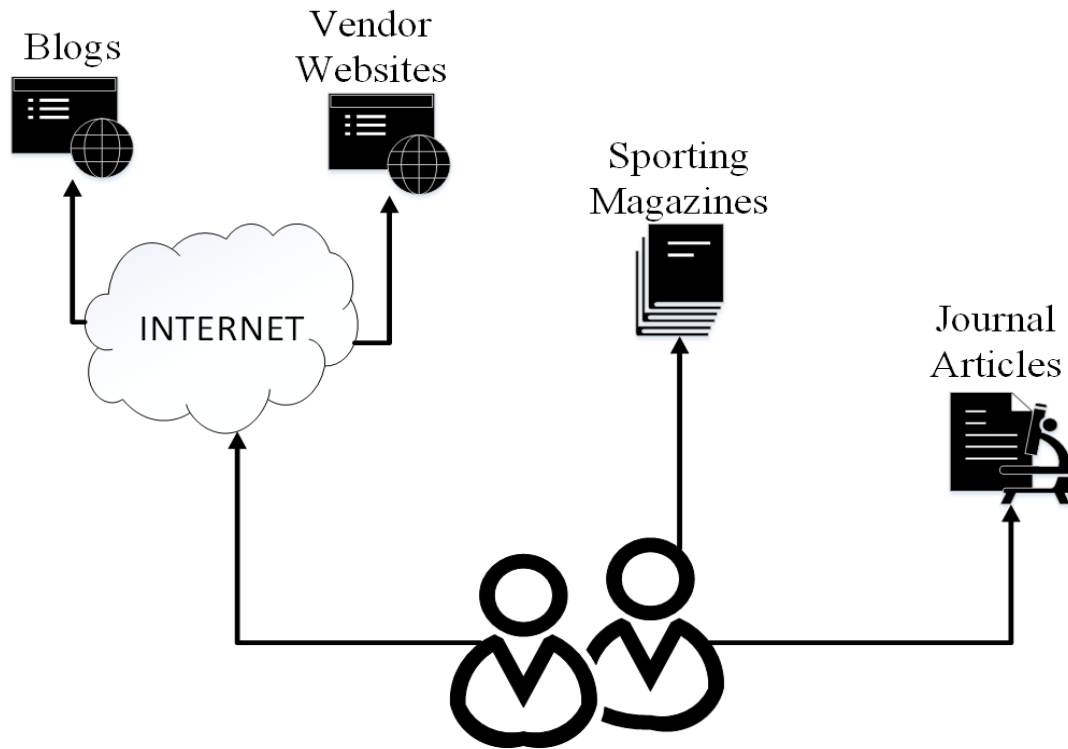
Figure 6.2: Possible Mobile Hardware Knowledge Creation Options

Figure 6.2 graphically depicts further possible options available to participants and event organizers to create knowledge on mobile technology hardware and software for safety purposes in adventure sport. These knowledge creation options are in no way limited to only Internet, Sporting Technology Magazines and Journal Articles, but should rather serve as a foundation to the knowledge creation process.

6.2.1.3 Human Element Summary

The human element must gain knowledge on the various mobile hardware and software, and establish the strengths and weaknesses associated with each technology. Once a technology fit is found, it must be implemented effectively to increase the safety of their events. Event Organizers research into the various mobile technology safety options is vital as they play a pivot role from organizing events, checking safety equipment and disqualifying participants if needed. Event organizers are responsible for creating awareness into safety with regards to mobile technologies. Event Organizers are also responsible for creating awareness on how mobile technology can assist in the safety of ocean and river kayaking events. Possible awareness creating options include safety workshops, guest speakers and vendor presentations.

6.2.2   Hardware

The second component to be discussed in the framework of this study is hardware. The hardware component of the framework refers to mobile technology hardware. As discussed in Chapter 3 Section 3.3.6 there are many forms of mobile technology devices available for the human element to implement into events. If ocean and river kayaking is to achieve an increase in safety, incorporating mobile technology hardware could assist in the safety events. As can been seen in Chapter 5 Figure 5.11 the ocean and river kayaking community does not view that mobile technology would hamper their event performance in any way.

The following discussion provides a description on what features and functionality mobile technology devices should contain in order to assist in improving the safety of ocean and river kayaking events.

6.2.2.1   Hardware Device Options

Based on literature reviews conducted in Chapter 3 Section 3.3.6 and Section 3.4.1, various mobile technology hardware was discovered that could be used to assist in the safety of the sport. Each device presented their own advantages and challenges in assisting in the safety of ocean and river kayaking. For example devices such as the Duotraq DQ30 Handset and SPOT GEN3 Handset are expensive to purchase, and may not function as intended in South Africa.

A device that each participant probably will own is a Smartphone as discovered in the online questionnaire, with 60% of the participants wanting to use their Smartphones with a tracking application. The questionnaire also discovered the concerns with using Smartphones as the hardware choice which can be viewed in Chapter 5 Figure 5.5. Three areas that are vitally important for any hardware device to provide safety as discussed in Chapter 3 are Network Technology, Global Positioning System and Communication Ability.

6.2.2.2   Network Technology

Mobile telecommunication networks provide a device with data and voice capabilities (as discussed in Chapter 3 Section 3.3.8). To use mobile technology hardware to assist in the safety of ocean and river kayaking by sending emergency notifications, network technology is required. In South Africa mobile network technology can be in the form of General Packet Radio Service(GPRS), 3G and 4G to mention a few. These technologies provide the mobile device with the ability of data transmission. Without an effective network technology the mobile hardware device would be unable to notify loved ones and emergency response teams in the event of an emergency. The concern with using a device dependent on network technologies is whether the device will have sufficient signal in the form of GPRS,

3G and 4G in remote locations to send emergency notifications. According to (Samsung, 2015), signal boosters can be used in remote locations in areas with little or no coverage. This may assist with the problem of poor signal strength, but these signal boosters may not be suited to accompany a kayaker during their events.

6.2.2.3 Global Positioning System

Global Positioning System (GPS) available in most smart devices have the ability to track an individual's position and the velocity of motion through a triangulation process. GPS is crucial in this frameworks as triangulation will determine the position of an adventure sport participant by calculating their distance from other known locations. GPS has the added benefit of not requiring an internet connection to determine the location of the individual, but rather uses a process of obtaining a location from 24 satellites as discussed in Chapter 3 Section 3.3.6. In order for GPS to function a hardware device only requires GPS functionality which is available in most smartphones, no internet connection is required, although not all map services may function (Apte, 2013). Having internet or data connection will increase the precision and time to make a location fix.

Based on the results of the online questionnaire in Chapter 5 Section 5.6, it was discovered that 50% of the participants frequently use GPS and 29% always use GPS with their smartphones. This demonstrates the ocean and river kayaking community are aware of the benefits that GPS presents in their daily lives, but require this technology to be implemented in their sport.

6.2.2.4 Communication Ability

For an effective solution to increase the safety of ocean and river kayaking, Network and GPS functionality should not operate in isolation. For example if a hardware device is able to obtain a GPS position, it can broadcast that position using data messaging. This would result in real-time safety measures that can be used to increase the safety of the sport.

Many forms of broadcasting the stranded individuals location could be used, for example Short Message Service (SMS), social media platforms (such as Whatsapp or Facebook) and email for example. It can be suggested that a Smartphone is ideally suited to all these requirements, but adventure sport participants can also consider a standalone device such as the Duotraq DQ30 Handset. The Duotraq DQ30 Handset (as discussed in Chapter 3 Section 3.4.1.1) can broadcast an emergency message sent via an email or SMS message to a contact person. The key for the human element is to realize the safety benefits that can be achieved by using the correct hardware device with adequate Network and GPS functionalities.

6.2.2.5 Non-Technical Considerations

The hardware component in the suggested framework of this study requires the human element to gain knowledge of the various mobile hardware devices available for safety purposes (as discussed in Chapter 3 Section 3.3.6). This would also require the human element to gain knowledge on the manufacturers of the mobile hardware technology (as discussed in Chapter 3 Section 3.4.1), to determine which mobile hardware technology would be a best fit for this type of sport.

Another main consideration for the human element is whether to purchase a new mobile device, or to use an existing capable device they might own to increase the safety of their events. An informed decision on purchasing new mobile hardware technology or using an existing device can only be made by knowledge creation through research.

The organizers of events could enforce that participants have some form of hardware when competing in an event. Alternatively if individuals already own the technology they simply need to include the hardware in the events with the supervision of the event organizers. Referring back to Chapter 5 Figure 5.15 which displays the willingness of participants to change their device for safety purposes. Results proved that the participants are willing to make the hardware switch to improve the safety of their events (as discussed in Chapter 5 Figure 5.15).

6.2.2.6 Hardware Implementation Guidelines

Based on the findings of this study there is evidence to put forward a theoretical suggestion on how mobile technology hardware could be used in an attempt to increase the safety of ocean and river kayaking events. The theoretical suggestion is visually depicted in Figure 6.3.

It was identified in Chapter 3 that a smartphone or devices such as the Duotraq DQ30, SPOT GEN3 or G-Layer YB3 handsets are suitable hardware to use in ocean and river kayaking events. These devices can be seen accompanying the participant during an event in Figure 6.3. The selected device requires GPS functionality to obtain the latitude and longitude position of the participant if they experience an emergency situation. The GPS co-ordinates can then be sent via data transmission using the available networks in South Africa to an emergency contact. Emergency contacts in Figure 6.3 are considered to be loved ones of the participants or emergency response teams such as the National Sea Rescue Institute.
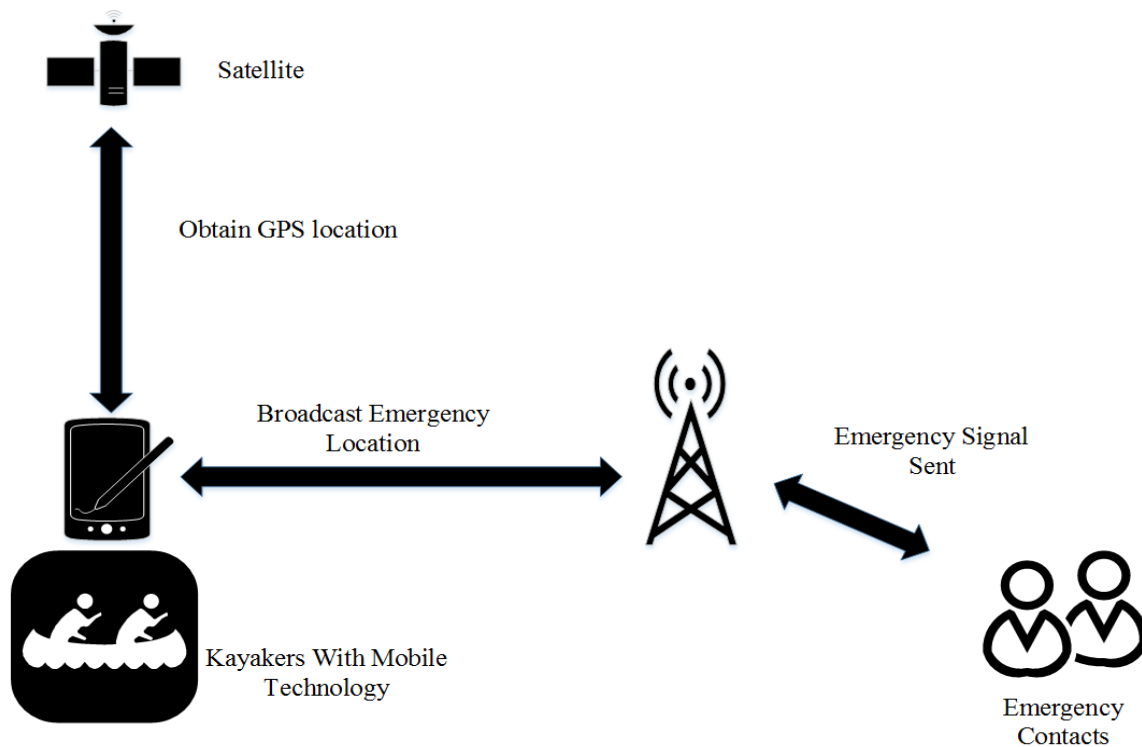
Figure 6.3: Suggested Hardware Implementation

6.2.2.7 Hardware Summary

This study identified various mobile hardware technologies that could be implemented into ocean and river kayaking events in an attempt to improve safety. Smartphones were identified as a suitable fit as most participants already own these devices according to the results of the online question conducted in Chapter 5. Standalone hardware devices such as the Duotraq DQ30, SPOT GEN3 or G-Layer YB3 handsets were also identified as adequate devices to assist in emergency situations. Knowledge creation on the various hardware devices is crucial to make an informed decision on the best suited hardware to assist in improving safety.

For a hardware device to offer the necessary safety functionality it was determined that Network Technology, GPS Functionality, and Communication Abilities were the vital components. An effective hardware solution to increase the safety of ocean and river kayaking requires all these components to work harmoniously to achieve the scenario depicted in Figure 6.3.

6.2.3 Software

Mobile technology software is the third component in the suggested framework of this study. The software segment closely resembles the Hardware segment, but rather focuses on the

functionality that software can provide for hardware devices such as smartphones. Various mobile software applications were (discussed in Chapter 3 Section 3.4.2), mobile operating systems (discussed in Chapter 3 Section 3.3.4), and Application Frameworks (discussed in Chapter 3 Section 3.3.3).

The following discussion provides a description of software considerations. These software considerations could provide the hardware (discussed in Section 6.2.2), with features and functionality to assist in improving the safety of ocean and river kayaking events.

6.2.3.1 Software Considerations

Mobile Operating Systems, (as discussed in Chapter 3 Section 3.3.4), are responsible for controlling feature functionality on a mobile device. These features may including GPS functionality, push notifications, camera control and text messaging to mention a few. It is important for the participants and emergency response teams to acquire knowledge on the various mobile operating systems, as it determines which mobile applications can be installed on the mobile device. Certain functionality may also only be available on a particular operating system.

The Software component differs from the Hardware component in that when an individual purchases a dedicated hardware device, (such as the devices discussed in Chapter 3 Section 3.4.1), the devices have pre-installed software. This pre-installed software has all the features and functionality required to assist in the safety of adventure sport.

In the cases where individuals and participants are using smartphones for safety purposes, third party software is available for download and configuration on an individual's device. Examples of these downloaded mobile technology applications include RSA SafeTrx and Endomondo as discussed in Chapter 3 Section 3.4.2.

6.2.3.2 Application Frameworks

As stated in Chapter 3 Section 3.3.3, Application Frameworks are used by developers to create applications that provide hardware devices with features and functionality. These features and functionality allow the concepts discussed in Section 6.2.2, namely Network Technology, GPS and Communication Ability to be implemented in an application. Without the software development kits (SDK) provided in the various Application Frameworks this would not be possible.

Chapter 3 Section 3.3.3 identified the Java ME Framework, Windows Mobile Framework and Android SDK as the dominant Application Frameworks available at the time of this study. This was evident from the results of the online questionnaire that demonstrated that majority of the participants owned a device running Android, Apple iOS and Windows

Mobile. Therefore when mobile software applications are developed to assist in the safety of ocean and river kayaking the Java ME Framework, Windows Mobile Framework and Android SDK should be considered.

There is also the option of creating a hybrid software application which would allow all smartphone devices with browser functionality the ability to run the application. The only concern is the application is not developed in the native language, and therefore not taking full advantage of the Application Framework developed for that particular device. Abed (2016) confirms this by stating native developed applications have an advantage as they are able to utilize the built-in capabilities of a hardware device.

6.2.3.3   Operating Systems

Chapter 3 Section 3.3.4 identified Android, Apple iOS, Windows Mobile and RIM Blackberry as the popular mobile operating systems in the South African market at the time of study. This finding was validated in Chapter 5 Section 5.6, with then ocean and river kayaking community selecting Android as the most preferred operating system. This finding coincides with the application frameworks which must be used to design and develop applications for the mentioned operating systems.

Situations may occur where mobile applications are developed for a particular operating system, or where some mobile application's function differently on various operating systems. Helppi (2017) states that an application can even behave differently mobile devices running the same operating system version with identical hardware configurations. It is therefore imperative that participants and event organizers have an understanding of how the suggested mobile application functions on the various mobile operating systems, and that all the safety features work as intended.

6.2.3.4   Mobile Applications

Excellent strides have been made in mobile application development, for example tracking applications such as RSA SafeTrx. For a Mobile Application to be effective in assisting in the safety of ocean and river kayaking is must use the functionality provided by the Hardware components. For example, the application must have the ability to broadcast and receive data, obtaining GPS positioning to be sent to emergency contacts and communication in the form of SMS, Social Media, or Email. Many of the Mobile Applications developed already have this ability, albeit not for ocean and river kayaking with the exception of RSA SafeTrx. Other features and functionality in the mobile applications that may prove useful in rescue operations include a compass, battery saving functionality and possibly heart rate monitoring.

Based on the literature review conducted in Chapter 3 Section 3.4.2, the RSA SafeTrx mobile application is the best fit as a solution with regards to the ocean and river kayaking community. Justification for this statement are that the application is free to download, globally tested and can monitor an individual event. A major advantage is this application is designed for most water sports, especially with regards to ocean events. At present the application is free to download, and is available for download from the Apple AppStore and Android Google Play. The RSA SafeTrx application is available on two of the three biggest mobile operating system platforms in South Africa during the writing of this study, as identified by Chapter 3 Figure 3.3 and validated by the findings of the online questionnaire in Chapter 5 Section 5.6 in which the participants selected the Android and iOS as their preferred mobile operating system. Even with the development of the RSA Saftrx application there is still room for growth as this is a generic water sports application. A purpose built mobile application designed specifically for the ocean and river kayaking may be required to increase participant safety.

As with the Hardware component in Figure 6.1, the Participants and Event Organizers must become acquainted with the various mobile software applications that are available on the market as well as the mobile operating systems that support the mobile applications.

6.2.3.5 Software Summary

Obtaining the relevant knowledge on all the aspects related to software discussed in this section is of paramount importance. This knowledge will allow the human element to make informed decisions on whether a particular application installed on a particular operating system has the necessary features and functionality to assist in the safety of this adventure sport. When existing or new mobile applications are discovered, participants and event organizers need to install and test the mobile applications to determine the features and functionalities, and very importantly what supported mobile operating systems the applications it can be installed on.

Research and knowledge creation on the various mobile operating systems and applications will provide individuals and event organizers with the ability to choose a solution for safety purposes. The mobile technology world has a vast amount of mobile operating systems and application to choose from, but selecting the right mobile operating systems and safety applications is the challenge.

6.2.4 Events

The two main event components stated in the framework of this study include Competition and Training Events. Both Competition and Training events may expose individuals to

dangerous isolated environments in which mobile technology hardware and software could play a part in increasing safety. As revealed by the online questionnaire that 61 out of the 102 (60%) participants expose themselves to isolated environments more than four times a month. This result alone reveals the need for some form of mobile technology to accompany the participants during their events when they find themselves in isolated environments. As identified in Chapter 5 Figure 5.3 most of the participant events are in river kayaking but a large majority participate in ocean and river kayaking events.

Training Events would result in an individual or a group of individuals training for a competitive event. There may be situations where an individual may venture into an isolated river or sea environment in an attempt to practice or hone a skill. If during a training event the individual experiences a problem of whatever nature, it may result in the individual being stranded. An example of this was when Barry Guy Marshall lost his life during an individual event as discussed in Chapter 2 Section 2.5. Barry Guy Marshall may or may not have been training for an event, but the point is that risks are elevated when an individual ventures into isolated environments on their own. It is in these situations that the Hardware and Software components of the framework are required to inform the relevant emergency contacts.

Competition events are different from the training events in that more people in the form of spectators, event organizers and general public are viewing or assisting in the event. Competitions are not free from danger as was discussed in Chapter 2 Section 2.5 where Mark Feather lost his life during the Pete Marlin World series surf ski race in East London.

6.3   Continuous Cycle Improvement

The suggested framework in this study was designed with a triangular nature. Therefore it could be combined in a continuous cycle for process improvement, to ensure that the framework in this study is continuously assessed and improved. A suitable solution to continuously evaluate the framework is the Plan Do Check Act (PDCA). This continuous process improvement model requires constant evaluation which teaches individuals or organizations to plan an action, implement or actually do the solution, check to see if the requirements have been met and finally act on the discoveries (Johnson, 2002). The entire cycle can then be revisited as can be seen viewed in Figure 6.4, which has been adapted from (Johnson, 2002) and applied to this study.
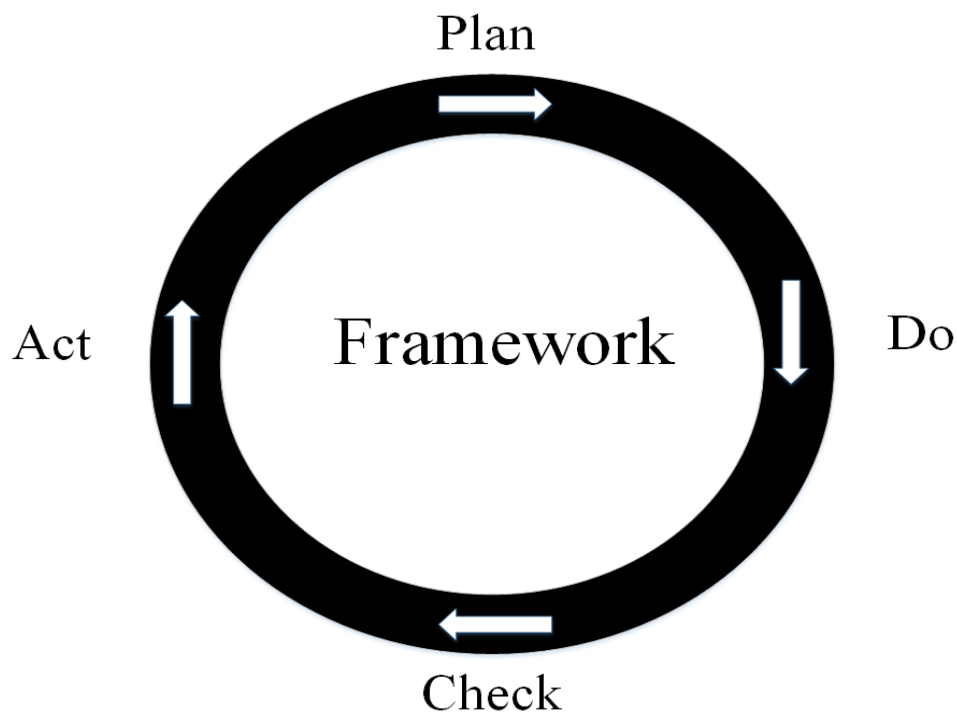
Figure 6.4: Plan-Do-Check-Act Model
(Johnson, 2002)

The following demonstrates an example of how the PDCA model can be applied to the framework of this study.

6.3.1 Plan

The relevant role player's identified in the Figure 6.1, that being the participants and event organizers, must identify that there are situations in which individuals have lost their lives as discussed in Chapter 2 Section 2.5. This presents a problem that needs planning to prevent future fatalities. The first step is to plan a solution for the problem which resulted in the individuals losing their lives. The identified solution can then be implemented in the Do it phase.

6.3.2 Do it

The Do it phase requires the relevant role players to either develop or identify a solution for assisting in the safety of adventure sport. This would involve identifying either a mobile technology device or a mobile application that would be used during competitive and training events. Once the identified technology has been established, it needs to be implemented to determine its effectiveness.

6.3.3 Check

Once a plan for the problem has been implemented the solution can then be evaluated. The main goal of this phase is to determine if the implemented solution achieved the desired result or goal. With regards to this study the implementation of the mobile hardware or mobile application would be evaluated for the effectiveness in assisting in improving the safety of ocean and river kayaking.

6.3.4 Act

The final phase of acting involves standardizing the implemented solution. If an emergency situation occurs in the future again there is a plan of action that can be followed, which has been checked and evaluated for its efficiency. Due to the cyclic nature the role players may decide to repeat the entire process to obtain a more effective solution in improving the safety of the sport.

6.4 Framework Summary

This chapter presented a mobile technology framework that was created to address the primary research question stated in this study, which was discussed in Chapter 1 Section 1.3. The framework attempted to create a solution that could be used to assist in improving the safety of ocean and river kayaking.

Figure 6.1 is evidence of the triangular artefact created for this study. The artefact represents the framework that consists of a Human Element, Hardware, Software and Events that must constantly interact to provide a holistic safety solution. It is recommended that the framework in this study be included in a cyclic design was so that any component can be revisited at any stage for improvement. Figure 6.2 visually depicted the suggested ways to obtain knowledge on the various mobile hardware and software options available to assist in increasing the safety of the sport.

The next chapter concludes this study in summarising the findings, and suggests future research to be considered.

Chapter 7

Conclusion

We can be absolutely certain only about things we do not understand. - Eric Hoffer
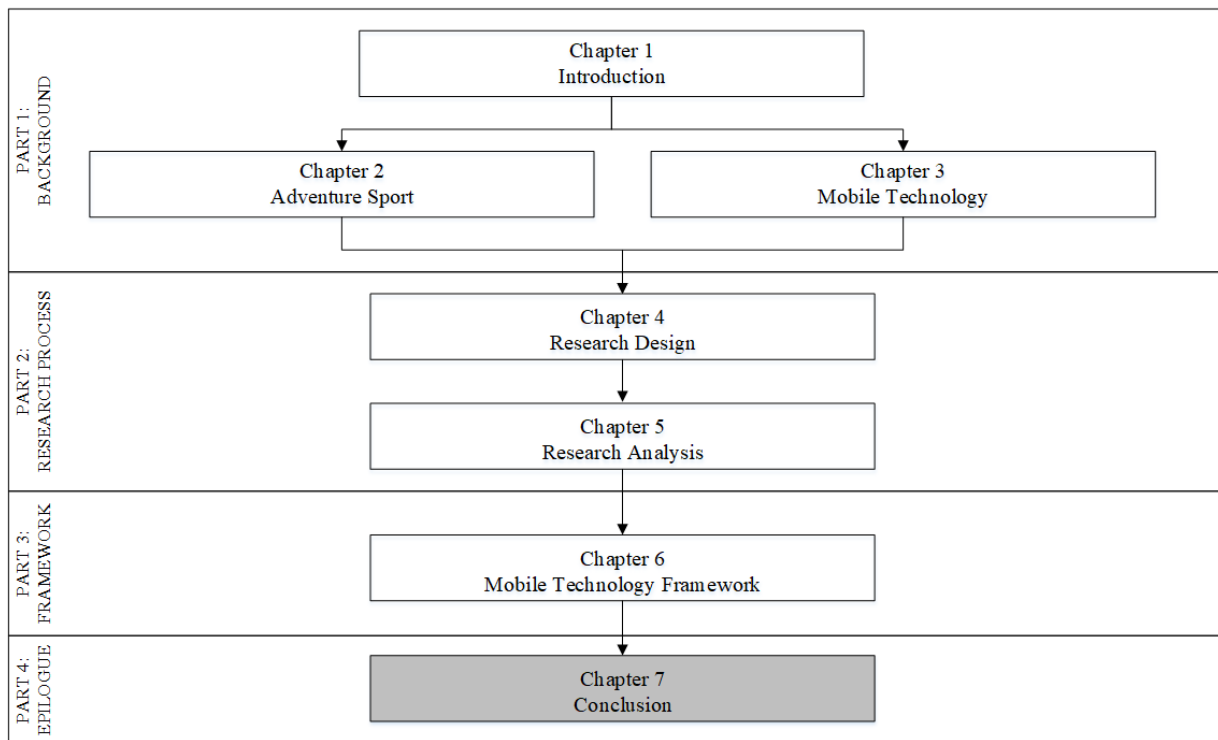
7.1   Introduction

This study focused on the adoption of mobile technology, consisting of mobile hardware and software, into ocean and river kayaking to assist in the safety of this form of adventure sport. This study revealed the clear and present danger that can exist with ocean and river kayaking, and based on the fatalities and emergency situations discussed in Chapter 2 Section 2.5, requires a solution with regards to safety. Mobile technology provides an adequate solution to assisting in safety of ocean and river kayaking as it is lightweight, compact and in most regards easy to use (as discussed in Chapter 3 Section 3.4).

Initial research suggested that no framework for assisting in the safety of ocean and river kayaking, in South Africa exists. Therefore there is a need to create such a framework, thus resulting in the mobile technology framework discussed in Chapter 6. This study was also motivated by providing a framework in which the various identified role players could constantly communicate and improve the adopted mobile technology into ocean and river kayaking. As was discussed in Chapter 6 the identified role players consisted of ocean and river kayaking participants, event organizers, mobile technology hardware and software as separate concerns.

7.2   Research Questions and Objectives

As part of this dissertation a problem statement, research questions and objectives were stated in Chapter 1 Section 1.3 and Section 1.4. The following section will revisit the research questions, objectives and the problem statement to highlight how each research requirement was met.

7.2.1   Discussion of the first research question/objective

The first secondary research question in this study was *What is the willingness of adventure sport participants to use mobile technology in their events?* To achieve the first research question, the first secondary objective was to *Identify the willingness of the participants to use mobile technology in adventure sporting events.* Chapter 5 Section 5.5 identified that the participants have a positive attitude towards the use of mobile technology in events. This positive attitude can be viewed in Chapter 5 Figure 5.10 and Figure 5.12 which visually displays the participant's willingness to use mobile technology in events and furthermore the positive attitude to purchasing mobile technology devices for safety purposes.

Meeting this first research objective demonstrated that the ocean and river kayaking appreciate the dangers associated with this sport and are open minded to the use of mobile technology.

7.2.2   Discussion of the second research question/objective

The second secondary research question was *What mobile technology factors may adversely affect search and rescue operations of stranded adventure sport participants?* The second secondary research objective, proposed in support of the secondary research question was to, *Identify the mobile technology factors that may adversely affect the search and rescue operations of stranded adventure sport participants.* These research criteria were aligned by identifying six possible factors that may effect search and rescue operations while using mobile technology were identified. The identified factors included battery life, signal strength, the device not being waterproof, loss of the device, theft and finally lack of technical knowledge. According to the ocean and river kayaking community and viewed in Chapter 5 Table 5.5, battery life and signal strength are the two main factors that may effect search operations.

7.2.3   Discussion of the third secondary research question/objective

The final third research question in this study was *What identified concepts and components could be incorporated into a mobile technology framework, to minimize the communication gap between participants and emergency response teams?* The final third research objective was to *Establish which concepts and components can be incorporated into a mobile technology framework, to minimize the communication gap between participants and emergency response teams.* The research conducted during the third research question and objective was an overall determining factor in the creation of the Theoretical Mobile Technology Framework in Chapter 6. The identified concepts and components were identified during the literature reviews and results from the online question and can be viewed in Chapter 6 Figure 6.1. The third secondary research question and objective was satisfied by identifying how the human element interact with hardware and software, to make events safer by minimizing the communication gap between participants and event organizers.

7.2.4   Discussion of the primary research question/objective

The primary research question stated in this study was *How can mobile technology be integrated into adventure sport from a South African context, to assist in the safety of the participants?* In an attempt to answer the primary research question the primary research objective was *To formulate a framework for the integration of mobile technology into adventure sport to improve participant safety, within the context of South Africa.*

The primary research question and objective was met in Chapter 6 Section 6.2. A component based framework was developed, which comprised of four role players and provided a discussion on how each component must work together in order to improve the safety of

the sport. The two literature reviews conducted in Chapter 2 and Chapter 3, as well as the findings from the online questionnaire conducted in Chapter 5 provided the foundation for the creation of the framework. The identified concepts and components of the suggested framework included a human element consisting of participants and event organizers, interacting with hardware and software to incorporate into events. The framework was also graphically represented in Chapter 6 Figure 6.1.

7.3   Problem Statement Revisited

The main problem addressed in this study is that *no framework currently exists within South Africa for integrating mobile technology into adventure sport for the purpose of increasing participant safety.*

Based on the problem statement of this study an artefact in the form of a framework was presented. This framework provides a possible solution on how mobile technology can be used to increase participant safety in adventure sport. The proposed framework was designed with all the identified roles players, including the human element, hardware, software and the kayaking Events. To further validate the objectives met in this study the next section will provide an overview of each chapter presented in this study.

7.4   Chapter Review

The first chapter in this study provided the necessary background information of the identified problem. This chapter established the research problem, research questions and objectives to achieve the research goals of the study. The research methods were also discussed and a visual chapter layout was presented.

Chapter 2 focused on exploring the world of adventure sport. This chapter brought to light the reasons individuals partake in this extreme type of sport and discussed the various forms of adventure sport that are popular in South Africa. The selected adventure sport was also presented, that being ocean and river kayaking. The chapter also included a discussion on situations where individuals lost their lives due to the extremity of the sport. The chapter concluded with explaining that currently mobile technology is not a requirement for this type of adventure sport according to SAMSA regulations.

Chapter 3 focused on exploring mobile technology with regards to hardware and software. A discussion on important mobile technology concepts was presented such as mobile technology services, applications, frameworks and mobile operating systems. The chapter also focused on mobile technology hardware and software options available for incorporation into adventure sport to increase participant safety.

Chapter 4 presented the research design implemented in this study. The chapter discussed the literature review process, the creation and refinement of the online questionnaire, how the data was analysed and discussed the proposed framework. The construction and deployment of the online questionnaire was also explained, outlining an eight stage sequence which was adapted from Cohen et al. (2011, p. 435). Finally, a discussion on the how the data obtained from the online questionnaire was interpreted and presented concluded the chapter.

Chapter 5 presented the data findings obtained from the online questionnaire which was submitted to ten paddling clubs in the Eastern Cape province of South Africa. The chapter discussed the four sections which made up the online questionnaire. Section 1 of the online questionnaire presented findings of the participants general information such as age, gender, ethnic background and marital status. Section 2 presented findings on the adventure sport the participants were involved in. Section 3 obtained responses on whether participants had used mobile technology to assist in emergency situations and determined the willingness to incorporate mobile technology into their events. The final section presented findings of how the participants use mobile technology and what the preferences are with regards to devices, operating systems and applications.

Chapter 6 attempted to illustrate how the safety of ocean and river kayaking could be increased by means of a framework. The framework consisted of a triangular design consisting of a human element, hardware, software and events as the framework components, including a discussion on each component.

Chapter 7 is the final chapter which concludes this study. The problem statement and objectives are revisited with a discussion on the research limitations and future research possibilities.

7.5   Research Limitation

The mobile technology hardware and software discussed in this study was not tested or evaluated to determine the effectiveness of increasing the safety of ocean and river kayaking. The suggested mobile hardware and software discussed was from a South African context and may not be suitable or as efficient in other countries. This study included data obtained from the Eastern Cape province of South Africa only, and future research could include a bigger sample population including all the clubs in South Africa. Findings from South Africa could also be compared to results obtained in other parts of the world in an attempt to find the best fit, to overcome an isolated viewpoint.

The following discussion in Section 7.6 will provide some suggestions for future research on this research problem.

7.6 Future Research Possibilities

The proposed framework in this study proved to be a possible solution in an attempt to increase the safety of ocean and river kayaking. Ideally the framework should be verified for its ability to be implemented as an actual solution. A future option would be to produce a prototype based on the findings of this study, which could be tested by the ocean and river kayaking community to determine its effectiveness. A further future possibility may be for a proposal to update the safety guidelines of SAMSA to include mobile technology devices during events.

Furthermore, the study could be analysed against other adventure sports. The lessons learnt and technology implementation in each sport could be compared to determine the effectiveness and implementation ability into ocean and river kayaking.

Finally, studies around this framework and the dangers associated with adventure sport should be developed to provide a greater awareness. Studies primarily focused on the use of mobile technology to increase the safety of all forms of adventure sport should be conducted. Technology is constantly evolving and therefore it is necessary to constantly evaluate the current technology implemented in the sport to determine if a more suitable solution exists.

7.7 Conclusion

Kayaking in South Africa is an extremely popular sport and can take place in either the ocean or rivers. As identified in this study, emergency situations can occur with this type of sport and mobile technology was suggested as a solution to improve safety. This chapter concludes the study and ensured that all the research objectives stated in Chapter 1 were accomplished. The primary and secondary research objectives were stated and an overview of each chapter in this study was provided. Research limitations that were experienced during the duration of the study was also discussed. To conclude the final chapter future research possibilities were outlined in order to improve the research topic area.

The purpose of this study was to create awareness of the dangers involved in ocean and river kayaking. This study identified that there is a need for mobile technology to be integrated into the sport to minimize the communication gap between participant's and emergency rescue teams during an emergency situation. The framework created in Chapter 6 would only be successful if there is active collaboration between all the role players including the human element, hardware, software and events. The research conducted in this paper identified the current use of mobile technology in ocean and river kayaking in the Eastern Cape province of South Africa. It was determined that at present mobile tech-

nology is not considered a necessity with regards to safety. The lack of mobile technology implementation is evident in the safety requirements list of SAMSA.

While this study identified various mobile hardware and software technologies, it was established that no single holistic solution exists for increasing the safety of ocean and river kayaking. It is therefore suggested that the research community collaborate with all the relevant role players to provide a solution to assist in increasing the safety of this type of adventure sport. A satisfactory eventual outcome of the adoption of the framework presented in this study would be the integration of mobile technology into ocean and river kayaking, thereby providing a safer sporting experience for the participants. The framework created in this study is a step in the right direction to increase the future safety of ocean and river kayaking. A closing thought for this study is could the loss of the three lives discussed in Chapter 2, have been prevented with the integration and effective use of mobile technology?

References

Abed, R. (2016). *Hybrid vs native mobile Apps. The answer is clear.* Retrieved 28 November 2017, from `https://ymedialabs.com/hybrid-vs-native-mobile-apps-the-answer-is-clear/`

Aker, J., & Mbiti, I. (2010). Mobile phones and economic development in Africa. *Center for Global Development Working Paper*(211).

Apple Developer. (2014). *Cocoa touch layer.* Retrieved 13 April 2016, from `https://developer.apple.com/library/ios/documentation/Miscellaneous/Conceptual/iPhoneOSTechOverview/iPhoneOSTechnologies/iPhoneOSTechnologies.html`

Apte, A. (2013). *Does GPS need internet connection to run on smart phone?* Retrieved 7 November 2017, from `https://www.quora.com/Does-GPS-need-internet-connection-to-run-on-smart-phone`

Banks, R. (2016). Mobile industry review. Retrieved 17 March 2016, from `http://www.mobileindustryreview.com/2015/01/3-billion-internet-users-2015.html`

Blackberry. (n.d.). *Blackberry, powered by Android.* Retrieved 20 April 2016, from `http://us.blackberry.com/software/smartphones/android.html`

Brace, I. (2008). *Questionnaire design: How to plan, structure and write survey material for effective market research.* London and Philadelphia: Kogan Page Publishers.

Breivik, G. (2010). Trends in adventure sports in a post-modern society. *Sport in society*, *13*(2), 260–273.

Brown, B. (2002). *Studying the use of mobile technology.* Springer.

Business Tech. (2015). *SA mobile market share: Vodacom vs MTN vs Cell C vs Telkom.* Retrieved 30 April 2016, from `http://businesstech.co.za/news/general/104249/sa-mobile-market-share-vodacom-vs-mtn-vs-cell-c-vs-telkom/`

Canoeing South Africa. (2015). The paddler's handbook. Retrieved 10 March 2016, from `http://www.canoesa.org.za/wp-content/uploads/2013/05/The-Paddlers-Handbook.pdf`

Charland, A., & Leroux, B. (2011). Mobile application development: web vs. native. *Communications of the ACM*, *54*(5), 49–53.

Ciaramitaro, B. L. (2011). *Mobile technology consumption: Opportunities and challenges: Opportunities and challenges.* IGI Global.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education.* Routledge Taylor and Francis Group.

Creswell, J., & Clark, V. (2011). *Understanding mixed methods research.* Sage.

Darcey, L., & Conder, S. (2012). *Android wireless application development volume i: Android essentials.* Indiana: Addison-Wesley.

De Vaus, D. (2013). *Surveys in social research.* United Kingdom: Routledge.

Duotraq. (2016). *Global tracking system.* Retrieved 28 May 2016, from `http://www.duotraq.com/DQ30-handset.asp`

Du Plooy, G. (2009). *Communication research: techniques, methods and applications.* Juta and Company Ltd.

Eadicicco, L. (2015). *The 10 most popular apps of 2015.* Retrieved 4 April 2016, from `http://time.com/4156902/most-popular-apps-2015/`

Emerson, R. W. (2015). Convenience sampling, random sampling, and snowball sampling: How does sampling affect the validity of research? *Journal of Visual Impairment & Blindness (Online), 109*(2), 164.

Eng, H. (2008). Technology to the rescue. *PC Magazine, 27*(6), 19 - 20. Retrieved from `http://search.ebscohost.com.ezproxy.iielearn.ac.za/login.aspx?direct=true&db=aph&AN=31546734&site=ehost-live`

Ewert, A. W., Sibthorp, J., & Sibthorp, R. J. (2014). *Outdoor adventure education: Foundations, theory, and research.* Human Kinetics.

Extreme-Sport. (2016). Macmillan Dictionary. Retrieved 29 February 2016, from `http://www.macmillandictionary.com/dictionary/british/extreme-sport`

Fling, B. (2009). *Mobile design and development: Practical concepts and techniques for creating mobile sites and web apps.* O'Reilly Media.

Fox, W., & Bayat, M. (2011). *A guide to managing research.* Juta and Company Ltd.

Fridell, R. (2008). *Sports technology.* Minneapolis: Lerner Publications.

Gething, P. W., & Tatem, A. J. (2011). Can mobile phone data improve emergency response to natural disasters? *PLOS medicine, 8.*

Giesen, D., Meertens, V., Vis-Visschers, R., & Beukenhorst, D. (2012). Questionnaire development. *The Hague, Heerlen, Netherlands.*

G-Layer. (2014a). *YB3.* Retrieved 21 July 2016, from `http://www.g-layer.com.au/yellowbrick/`

G-Layer. (2014b). *YB3.* Retrieved 22 July 2016, from `http://www.g-layer.com.au/product/yellowbrick-v3-mkii-professional/`

Goggin, G. (2012). *Cell phone culture: Mobile technology in everyday life.* Routledge.

Grønli, T.-M., Hansen, J., & Ghinea, G. (2010). Android vs windows mobile vs JAVA ME. In *Pros 3 intl conf on pervasive technologies related to assistive rd environments.*

GSMArena. (2016). *Operating systems.* Retrieved 18 April 2016, from `http://www.uswitch.com/mobiles/guides/mobile-operating-systems/`

Helppi, V.-V. (2017). *What every app developer should know about android.* Retrieved 17 October 2017, from `https://www.smashingmagazine.com/2014/10/what-every-app-developer-should-know-about-android/`

Hildenbrand, J. (2013). *What is stock android?* Retrieved 15 April 2016, from `http://www.androidcentral.com/what-stock-android`

Huey, R. B., & Eguskitza, X. (2001). Limits to human performance: elevated risks on high mountains. *Journal of experimental biology, 204*(18), 3115–3119.

Hutchinson, A. (2016). What makes extreme athletes take risks? Retrieved 12 February 2016, from `http://www.theglobeandmail.com/life/health-and-fitness/fitness/what-makes-extreme-athletes-take-risks/article17369458/`

Iliescu, O. (2011). *PRO JAVA ME APPS: Building commercial quality JAVA ME APPS.*

New York: Springer.

Isaksen, J. (2012). The psychology of extreme sports: addicts, not loonies. Retrieved 10 September 2015, from `http://www.popularsocialscience.com/2012/11/05/the-psychology-of-extreme-sports-addicts-not-loonies/`

ITWEB. (2015). Samsung is SA's top cellular brand. Retrieved 25 October 2015, from `http://www.itweb.co.za/index.php?option=com_content&view=article&id=147104:Samsung-is-SA-s-top-cellular-brand&catid=260`

Jidenma, N. (2014). *How africa's mobile revolution is disrupting the continent.* Retrieved 4 April 2016, from `http://edition.cnn.com/2014/01/24/business/davos-africa-mobile-explosion/`

Johnson, C. N. (2002). The benefits of PDCA. *Quality Progress*, *35*(5), 120.

Kakihara, M., & Sorensen, C. (2002). Mobility: An extended perspective. In (pp. 1756–1766).

Kane, M. J. (2010). Adventure as a cultural foundation: Sport and tourism in new zealand. *Journal of Sport & Tourism*, *15*(1), 27–44.

Khan, D. U., Ananthanarayan, S., Le, A., & Siek, K. (2012). Evaluation of physical activity monitoring applications for android. In *Ubicomp 2012 workshop on evaluating off-the-shelf technologies for personal health monitoring.*

Kothari, C. (2004). *Research methodology: methods and techniques.* New age international.

Kotzé, T., Anderson, O., & Summerfield, K. (2016). Technophobia: Gender differences in the adoption of high-technology consumer products. *South African Journal of Business Management*, *47*(1), 21–28.

Kumar, A. (2002). *Research methodology in social science.* Sarup and Sons.

Laviolette, P., Abramson, A., Dant, T., Wheaton, B., Herzfeld, M., & Katz, S. (2008). Hazardous sport? *Anthropology Today*, *23*(6).

Lee, W.-M. (2012). *Beginning Android 4 application development.* John Wiley and Sons.

Leggett, J. (2016). *Mobile operating systems.* Retrieved 18 April 2016, from `http://www.uswitch.com/mobiles/guides/mobile-operating-systems/`

Martin, D. (2013). Whitewater kayaker's death illustrates the danger of her sport. Retrieved 5 March 2016, from `http://www.cbsnews.com/news/whitewater-kayakers-death-illustrates-the-danger-of-her-sport/`

Matthews, K. (2015). *8 apps and websites to improve your kayaking experience.* Retrieved 22 June 2016, from `http://www.makeuseof.com/tag/8-apps-websites-improve-kayaking-experience/`

McCann, J., & Bryson, D. (2009). *Smart clothes and wearable technology.* Elsevier.

McNamee, M. J. (2007). *Philosophy, risk and adventure sports.* Routledge.

Meier, R. (2012). *Professional Android 4 application development.* Indianapolis: John Wiley & Sons.

Memon, A. (2013). *Advances in computers* (Vol. 89). Oxford: Elsevier.

Miller, J. B. (2014). *Internet technologies and information services.* ABC-CLIO.

Mills, C., & Haskins, B. (2018, March). Using mobile technology in an adventure sport. In *2018 conference on information communications technology and society (ictas)* (p. 1-6). doi: 10.1109/ICTAS.2018.8368737

Mochiko, T. (2015). *Mobile virtual networks: Can me & you compete?* Retrieved 02 May 2016, from `http://www.financialmail.co.za/features/2015/04/`

30/mobile-virtual-networks-can-meyou-compete

Morgan, D., Moore, K., & Mansell, R. (2005). Adventure tourists on water: linking expectations, affect, achievement and enjoyment to the sports tourism adventure. *Journal of sport tourism*, *10*(1), 73–88.

Moser, C. A., & Kalton, G. (1977). Survey methods in social investigation. *Survey methods in social investigation.*(2nd Edition).

Mousley, R. (2016). Surfski paddler dies at sea in port elizabeth. Retrieved 10 March 2016, from `http://www.surfski.info/latest-news/story/187/surfski-paddler -dies-at-sea-%E2%80%93-port-elizabeth.html`

NSRI. (2017). *Free App SafeTrx for smart phones.* Retrieved 02 April 2017, from `http://www.nsri.org.za/2015/02/nsri-announces-the-launch-of-a -free-safetrx-smart-phone-app/`

Oates, B. J. (2005). *Researching information systems and computing.* Sage.

O'leary, Z. (2004). *The essential guide to doing research.* Sage.

Oppenheim, A. N. (1992). *Questionnaire design, interviewing and attitude measurement.* London: Pinter.

Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization science*, *11*(4), 404–428.

Pattnaik, P. K., & Mall, R. (2015). *Fundamentals of mobile computing.* Delhi: PHI Learning Pvt. Ltd.

Perez, S. (2013). *Life 360, a family networking app with more users than foursquare, is not headed for cars and smart home systems.* Retrieved 31 May 2016, from `http:// techcrunch.com/2013/04/26/life360-a-family-networking-app-with-more -users-than-foursquare-is-now-headed-for-cars-smart-home-systems/`

Phandle, G. (2014). Paddler died due to drowning. Retrieved 5 March 2016, from `http:// www.dispatchlive.co.za/news/2014/11/20/paddler-died-due-to-drowning/`

Priest, S., & Martin, P. (1985). The adventure experience paradigm.

Rainczuk, J. P., & Schmidt, T. (2008, July 1). Personal locator beacon. (US Patent 7,394,384)

Rawlins, L. K. (2015). *SA LTE speeds one of the world's lowest.* Retrieved 27 April 2016, from `http://www.itweb.co.za/index.php?option=com _content&view=article&id=146489`

Rodriguez, J. (2015). *Fundamentals of 5g mobile networks.* United Kingdom: John Wiley & Sons.

Rogers, Y. S., Sharp, H., & Preece, J. (2011). *Interaction design: beyond human-computer interaction.* John Wiley and Sons.

Rowlands, D., & James, D. (2011). Real time data streaming from smart phones. *Procedia Engineering*, *13*, 464–469.

Sahin, H. M. (2014). Investigating the motivations and expectations of individuals interested in paragliding. *Anthropologist*, *18*(3), 949–957.

Salvo, P. (2013). *Wearable technologies for sweat rate and conductivity sensors: design and principles.* Anchor Academic Publishing.

Samsa. (2004). South African Maritime Safety Authority. *Merchant Shipping Act*, *1292*, 5–7.

Samsung. (2015). *Tips and tricks to boosting a cell phone signal.* Retrieved 9 November

2017, from `http://techlife.samsung.com/tips-tricks-boosting-cell-phone-signal-1048.html`

Schöffl, V., Morrison, A., Hefti, U., Ullrich, S., & Küpper, T. (2011). The UIAA medical commission injury classification for mountaineering and climbing sports. *Wilderness & environmental medicine, 22*(1).

SearchNetworking.TechTarget. (2016). *Aggregator.* Retrieved 26 April 2016, from `http://searchnetworking.techtarget.com/definition/aggregator`

Seaworthy. (2001). *Sports Illustrated, 95.* Retrieved 12 February 2016, from `http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=5142353&site=ehost-live`

Smith, G. A. (2015). Mountaineering. In *Encyclopedia Britannica.* Retrieved 18 February 2016, from `http://global.britannica.com/topic/mountaineering`

South Africa, C. (2016). *Five national canoe unions.* Retrieved 9 February 2016, from `http://www.canoesa.org.za/`

SouthAfrica.Info. (2015). *South africa: adventure heaven!* Retrieved 5 July 2015, from `http://www.southafrica.info/travel/adventure/adventure.htm#.Vcyw9vmqqkp`

SPOT. (2016a). *Coverage map.* Retrieved 30 May 2016, from `http://africa.findmespot.com/en/index.php?cid=108#howitworks`

SPOT. (2016b). *Life is good on the water.* Retrieved 30 May 2016, from `http://www.findmespot.com/spotadventures/?show_activity=kayakers`

SPOT. (2016c). *New! spot gen3.* Retrieved 30 May 2016, from `http://www.findmespot.com/en/index.php?cid=100`

Taylor, K., Abdulla, U. A., Helmer, R. J., Lee, J., & Blanchonette, I. (2011). Activity classification with smart phones for sports activities. *Procedia Engineering, 13*, 428–433.

TechTarget. (2017). *Framework.* Retrieved 2 November 2017, from `http://whatis.techtarget.com/definition/framework`

Thompson, E. (2003). Integrating PDA, GPS and GIS technologies for mobile traffic data acquisition and traffic data analysis. *Unpublished masters thesis. IT University of Goteborg, Sweden.*

Tognazzini, B. (1999). Emergency locator device transmitting location data by wireless telephone communications.
(US Patent 5,914,675)

USCLibraries. (2015). Organizing your social sciences research paper. Retrieved 9 July 2015, from `http://libguides.usc.edu/writingguide/literaturereview`

Vickey, T. A., & Breslin, J. G. (2012). A study on Twitter usage for fitness self-reporting via mobile apps. In *AAAI Spring Symposium: Self-tracking and collective intelligence for personal wellness.*

Vodacom. (n.d.). *WASP aggregator list.* Retrieved 26 April 2016, from `http://searchnetworking.techtarget.com/definition/aggregator`

Wegner, T. (2000). *Applied business statistics, methods and applications.* South Africa: The Rustica Press.

Wegner, T. (2011). *Applied business statistics, methods and excel-based applications.* South Africa: Juta and Company Ltd.

Wheaton, B. (2004). *Understanding lifestyle sports consumption, identity and difference.* 11 New Fetter Lane, London EC4P 4EE: Routledge.

Woyke, E. (2014). *The smartphone: Anatomy of an industry.* New York:The New Press.

Wyse, S. (2011). What is the difference between qualitative research and quantitative research? Retrieved 9 August 2015, from `http://www.snapsurveys.com/blog/what-is-the-difference-between-qualitative-research-and-quantitative-research/`

Yaghmour, K. (2013). *Embedded android: Porting, extending, and customizing.* Calafornia: O'Reilly Media, Inc.

Zeller, T., Billing, A., & Lob, G. (1992). Injuries in paragliding. *International Orthopaedics.*

Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking.* Cambridge university press.

Appendix A

This section contains the questions that were created for this study and used in the online questionnaire.

SECTION 1: GENERAL INFORMATION

1.1) Indicate your gender.

○ Male

○ Female

1.2) Indicate which age category you belong to.

○ 20 - 29

○ 30 - 39

○ 40 - 49

○ 50 - 59

○ 60+

1.3) Indicate your ethnic origin.

○ Asian

○ Black

○ Coloured

○ White

○ Other

1.4) Please indicate you marital status.

○ Married

○ Single

○ Divorced

SECTION 2: ADVENTURE SPORT

2.1) Please indicate which adventure sport you currently partake in?

       ○ River Kayaking

       ○ Ocean Kayaking

       ○ River and Ocean Kayaking

2.2) Indicate how long you have been competing in your selected adventure sport.

       ○ Less than 1 year

       ○ 1 to 5 years

       ○ 6 to 10 years

       ○ 11 to 20 years

       ○ 20+ years

2.3) Indicate your level of involvement in the adventure sporting community.

       ○ Recreational Member

       ○ Club Member

       ○ Provincial Member

       ○ National Member

2.4) Unfortunately accidents do occur in adventure sport. Have you ever been in a situation or witnessed an incident that left you or another individual stranded, waiting for emergency rescue.

       ○ Yes

       ○ No

2.5) Which of the following would best describe a reason for an individual being stranded and requiring an emergency rescue in your adventure sport.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Neglect of Safety Regualtions	○	○	○	○	○

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Reckless Behaviour	○	○	○	○	○

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Inexperience on behalf of the individual	○	○	○	○	○

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Inadequate search and rescue technology	○	○	○	○	○

2.6) How many times a month do you expose yourself to isolated environments in your chosen adventure sport.

○ Once a month

○ Less than four(4) times a month

○ More than four(4) times a month

○ Other

2.7) Please indicate by selecting which safety equipment you have during an event.

Kayaking Jacket

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

Thermal Clothing

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

At least 10lt of boat bouyancy

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

Throw Ropes

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

Polyethylene Helmet

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

Drinking Systems

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

Spray Decks

	1	2	3	4	5	
Not at all	○	○	○	○	○	Always

2.8) Do you participate in any other form of adventure sport?

	Never	Seldom	Regularly	Always
Mountaineering	○	○	○	○
Hangliding	○	○	○	○
Hiking	○	○	○	○
Mountain Bike Expeditions	○	○	○	○
Cross Country Marathons	○	○	○	○
Surfing	○	○	○	○

White Water Rafting	○	○	○	○
Sky Diving	○	○	○	○

SECTION 3: GENERAL MOBILE TECHNOLOGY

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I would consider using mobile technology in my adventure sporting events.	○	○	○	○	○
I feel using mobile technology during my sporting event would hamper my performance.	○	○	○	○	○
Your local club or event organizers actively drive individuals to use mobile technology to improve safety?	○	○	○	○	○
I would buy a mobile technology device to assist in emergency situations?	○	○	○	○	○
I would purchase a smart phone application to assist in emergency situations?	○	○	○	○	○
I have heard of or witnessed situations where mobile technology helped stranded individuals to be rescued.	○	○	○	○	○
If I was stranded in an emergency situation during a practice or actual event, my loved ones would like to monitor and view my locations?	○	○	○	○	○
Emergency response teams are well prepared in the Eastern Cape to find missing or stranded individuals?	○	○	○	○	○

Emergency response teams use mobile technology to find missing or stranded individuals?	○	○	○	○	○

SECTION 4: MOBILE TECHNOLOGY

4.1) Please indicate what you currently use your mobile device for.

	Never	Seldom	Regularly	Always
Social Media	○	○	○	○
Making Calls	○	○	○	○
Playing Music or Watching Movies	○	○	○	○
Taking Photos	○	○	○	○
Location Based Service (GPS)	○	○	○	○
Fitness Tracking	○	○	○	○

4.2) Please indicate which mobile technology would be best suited in you adventure sporting events.

○ Smart phone with tracking application

○ Standalone handheld GPS device

○ GPS sensor

○ Wearable device such as a waterproof smart watch

○ Other

4.3) Have you ever witnessed or heard of situations where mobile technology helped stranded individuals to be rescued?

○ Yes

○ No

4.4) Please indicate which factors you think would affect the search and rescue of stranded adventure sport individuals using mobile technology in an event.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Battery Life	○	○	○	○	○
Mobile signal strength	○	○	○	○	○
A device not being water-proof	○	○	○	○	○
Losing the device in events	○	○	○	○	○
Theft of the device by other participants	○	○	○	○	○
Lack of technical knowledge	○	○	○	○	○

4.5) Please indicate which mobile technology operating system you are currently using.

○ Android

○ iOS

○ Windows Mobile

○ Blackberry OS

○ Other

4.6) On a scale of 1 to 5, if a mobile device application was made available in attempt to increase the safety of your adventure sport, would you consider changing your existing smart phone to use the application?

	1	2	3	4	5	
No	○	○	○	○	○	Yes

4.7) Would you be available for further questioning?

○ Yes

○ No

End of Questionnaire

Appendix B

This appendix contains the reference to a paper presented at the International Communication Technology & Society Conference, held on the 8th and 9th of March 2018, Durban, South Africa.

(Mills & Haskins, 2018)
The presented paper received the follow-up best paper award for the conference.