DURBAN UNIVERSITY OF TECHNOLOGY
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EXPLORING PUBLIC-PRIVATE PARTNERSHIPS FOR ENHANCING BORDER SECURITY THROUGH SPACE TECHNOLOGY IN SOUTH AFRICA

Submitted in fulfilment of the requirements of the degree of

Doctor of Philosophy in Management Sciences

Specialising in Business Administration

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at the

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NOVEMBER 2021

Supervisor: Dr. A.T. Agbenyegah **Date**: 12 November 2021

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(Moses Thabo Katjisa Nkhoma)

NOVEMBER 2021

APPROVED FOR FINAL SUBMISSION BY

Supervisor: Dr. A.T. Agbenyegah

Signature……. **Date**: 12 November 2021

DECLARATION

I the undersigned hereby declare that this thesis submitted for the Degree of Doctor of Philosophy in Management Sciences specialising in Business Administration in the Faculty of Management Sciences at the Durban University of Technology is my own original work and has not been previously submitted to any other institution of higher learning. I further declare that all sources cited or quoted are indicated and acknowledged in the comprehensive bibliography list.

Signature Date: 12 November 2021

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CONFIRMATION OF LANGUAGE EDITING

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CONFIRMATION OF EDITING

I, Margaret Linström, hereby confirm that I language edited the doctoral thesis of Moses Thabo Katjisa Nkhoma, student number 21856728, entitled "Exploring public-private partnerships for enhancing border security through space technology in South Africa".

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ABSTRACT

The failure of the South African border security authorities to provide effective border security continues to be a grave national security problem. Their inability to provide effective border security is due to certain factors. These factors include a fragmented approach to border security management, as well as other socio-technical factors of border security, such as the absence of physical barriers in many parts of the country's land borders; the shortage of physical and human resources; and ineffective methods of controlling and monitoring South Africa's land borders. Given this, the aim of this research was to examine the practicability of employing space technology to address the identified border security challenges. It further sought to explore the opportunities of forming effective partnerships between the public sector and the private space technology sector to address the identified challenges through the application of space technology. Space technology is being embraced by many developed and developing countries as an alternative to the conventional methods of controlling and monitoring land borders. Furthermore, public-private partnerships are becoming an important feature in addressing national security and public safety challenges, as well as in the delivery of various space technology projects, in some countries.

The study was qualitative in nature and the primary data was collected using documentary sources and semi-structured interviews. The findings of this research revealed that South Africa was experiencing significant challenges in controlling and monitoring its land borders. Consequently, cross-border criminal activities, consisting of amongst others, border jumping, human smuggling, stock theft, wildlife poaching and smuggling, as well as the smuggling of goods and stolen vehicles, continue unabated. To address the identified problem, this research proposes the integration of various space technologies with other socio-technical solutions to control and monitor South Africa's international land borders. It further proposes the formation of effective partnerships among border security authorities, other government departments, the private space technology sector, and other private partners for the development and collaborative operation of space technologies for border security and for other societal applications.

Key concepts: border security; space technology; public-private partnership

LIST OF ABBREVIATIONS

ABIS	Automated Biometric Identification System
ACSM	Border Management Programme for Central Asia
AEB	Brazilian Space Agency
APOPS	Asset Procurement and Operating Partnership Systems
APP	Advance Passenger Processing
ATM	Automatic Teller Machines
AU	African Union
BBO	Buy Build-Operate
BCOCC	Border Control Operational Coordinating Committee
BCSF	Border-Community Security Forums
BDO	Build-Develop-Operate
BMA	Border Management Authority
BOM	Build-Own-Maintain
BOMCA	Border Management Programme for Central Asia
BOO	Build-Own-Operate
BOT	Build Operate, Transfer
BSF	Border Safeguarding Forum
CAA	Civil Aviation Authority
CBERS	Chinese-Brazilian Earth Resource Satellite
CBP	Customs and Border Protection
CCPPP	Canadian Council for Public-Private Partnerships
CCTV	Close Circuit Television
CJOPS	Chief of Joint Operations
CJS	Criminal Justice System
CNSA	China's National Space Administration
C-ORD	Commercialization Operational Requirements Document
CSIR	Council for Scientific and Industrial Research
CW	Corruption Watch
DALRRD	Department of Agriculture Land Reform and Rural Development
DBO	Design-Build-Operate
DBOT	Design, Build, Operate and Transfer
DCMF	Design-Construct-Manage-Finance
DCS	Department of Correctional Services
DFBOT	Design, Finance, Build, Operate, Transfer
DFBOT	Design, Finance, Build, Operate and Transfer
DFO	Design Finance Operate
DFO	Design, Finance and Operate
DHA	Department of Home Affairs
DHS	Department of Homeland Security
DI	Defence Intelligence

DOD	Department of Defence
DOH	Department of Health
DOS	Department of State
DOT	Department of Tourism
DOT	Department of Transport
DPW	Department of Public Works
DRC	Democratic Republic of Congo
DST	Department of Science and Technology
DTI	Department of Trade and Industry
DTI	Design and Transfer
eMCS	enhanced Movement Control System
EO	Executive Outcomes
EU	European Union
EZZ	Exclusive Economic Zone
FDA	Federal Aviation Administration
FEMA	Federal Emergency Management
FIFA	Federation of International Football Association
GATS	General Agreement on Trade in Services
GCIS	Government Communications and Information System
GIS	Geographical Information Systems
GLONASS	Russian Global Orbiting Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRRL	Gautrain Rapid Rail Link
IACF	Inter-Agency Clearing Forum
IALCH	Inkosi Albert Luthuli Central Hospital
IBMS	Integrated Border Management Strategy
ICAO	International Civil Aviation Authority
ICE	Immigration and Customs Enforcement
IMF	International Monetary Fund
INCSR	Indian National Committee for Space Research
IOL	Independent Online
IOM	International Organization for Migration
ISR	Intelligence, Surveillance, and Reconnaissance
ISRO	Indian Space Research Organisation
ISS	International Space Station
IT	Information Technology
JCPS	Justice, Crime Prevention and Security
JOC	Joint Operations Committee
JTACQ	Joint Tactical Headquarters
KNP	Kruger National Park
LOO	Lease-Own-Operate

MDG	Millennium Development Goals
MEC	Member of the Executive Committee
MECB	Complete Brazilian Space Mission
MFMA	Municipal Finance Management Act
NASA	National Aeronautics and Space Administration
NATJOINTS	National Joint Operations and Intelligence Structure
NCS	Nigeria Customs Service
NDP	National Development Plan
NIDS	National Interdepartmental Structure
NISP	National Institute for Space Research
NSS	National Space Strategy
NT	National Treasury
OCIU	Organised Crime Investigation Unit
OECD	Organisation for Economic Co-operation and Development
OSBP	One-Stop-Border-Post
PFMA	Public Finance Management Act
PHS	Port Health Services
PMAA	Prohibition of Mercenary Activities Act
PMC	Port Management Committee
PMG	Parliamentary Monitoring Group
PPP	Public-Private Partnership
PROVJOINTS	Provincial Joint Operations and Intelligence Structure
PSIRA	Private Security Industry Regulatory Act
RFP	Request for Proposal
RFQ	Request for Qualification
RPV	Remotely Piloted Vehicle
RSA	Republic of South Africa
RTMC	Road Traffic Management Corporation
RTMC	Road Traffic Management Corporation
S&TD	Science & Technology Directorate
SACAA	South African Civil Aviation Authority
SABC	South African Broadcasting Authority
SACSA	South African Council for Space Affairs
SACSA	South African Council for Space Affairs
SADC	Southern African Development Community
SANDF	South African National Defence Force
SAPS	South African Police Service
SARPCCO	Southern African Regional Police Chiefs Cooperation Organisation
SARS	South African Revenue Service
SCRA	Standing Committee for Refugee Affairs
SECURE	System Efficacy through Commercialization, Utilization, Relevance and Evaluation
SGDC	Geostationary Defence and Strategic Communication Satellites

SKA	Square Kilometre Array
SMME	Small Medium Micro Enterprises
SS	Secret Services
SSA	State Security Agency
SSTC	Space Science Technology Centre
STES	Satellite Telecommunication Earth Station
STIC	Stock Theft Information Centre
TR	Treasury Regulation
TRAC	Trans African Concessions
TSA	Transportation Security Administration
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
UNCTCO	United Nations Convention on Transnational Organised Crime
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO	United Nations Economic and Social Council
UNODC	United Nations Office on Drugs and Crime
UNOOSA	United Nations Office for Outer Space Affairs
USA	United States of America
USAID	United States Agency For International Development
USCIS	United States Citizenship and Immigration Services
VOC	Venue Operations Centre
WCO	World Customs Organisation
WWW	World Wide Web

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CHAPTER 1

GENERAL ORIENTATION TO THE TOPIC AND THESIS

1.1 Introduction and background to the research

South Africa is the 25th largest country in the world. It is approximately 1 219 090 square kilometres in size and shares its borders with six countries, namely Namibia, eSwatini, Botswana, Lesotho, Zimbabwe, and Mozambique. South Africa's international land borders with its neighbouring countries stretch for more than 4700 kilometres, with 53 land border posts between these six neighbouring countries (World Atlas, 2019; SA News, 2017; South African Revenue Service, 2019). Given the length and breadth of the South African land borders and the threats and risks of illegal migration and other transnational crimes, the provision of effective land border security becomes an important component of the entire South African safety and security architecture. Regrettably, the provision of effective border security remains a great challenge to South Africa. This is attributed to several factors, including the vastness of the South African land borders; the absence of physical barriers along the land borders; physical and human resource constraints to effectively safeguard, control and monitor the land borders; and poor coordination among border security authorities (TimesLIVE, 2019a; Maqhina, 2019; SA News, 2019; DefenceWeb, 2020).

Although the emergence of space technology has been embraced by countries such as the United States of America (USA), India, Egypt and Europe as an alternative to conventional methods of safeguarding, controlling and monitoring land borders (e.g. vehicle and foot patrols), South Africa is yet to fully adopt space technology to address its land border security challenges (Thompson, 2013; Gadda & Patil, 2013; Shishkov, Hristozov & Janssen, 2017; Van den Hoven, Katara & Pokhriyal, 2017).

Public-private partnerships (PPPs) have also entered strategic sectors, such as the military and policing, and are becoming an important feature when devising strategies and methods of addressing national security and policing challenges in some

developed countries. This aspect is also not adequately covered in the South African context (Busch & Givens, 2012; Bergin, 2019). Given the pivotal role effective border security plays in minimising transnational criminal activities and further ensuring a greater sense of security for South African residents and any other persons within the boundaries of South Africa, this empirical research sought to examine the practicability of employing space technology to address land border security challenges in South Africa. This research further sought to explore the role the private space technology sector could play in enhancing border security through a variety of partnerships with state border security agencies, other government departments, and private interests affected by border security challenges in South Africa.

1.2 Problem statement

South Africa faces a mammoth challenge of managing and controlling its porous international land borders. Illegal border jumping; human smuggling and trafficking; goods smuggling; and stock and vehicle theft, and their consequent smuggling across the land borders have become prevalent in South Africa in recent years. Regrettably, the vastness of the South African land borders; variations in the land border terrain; and inadequate human and physical resources for border security authorities make it difficult for South African border authorities to safeguard, monitor and control the land borders effectively. These challenges have been noted and acknowledged by South Africa's cabinet ministers responsible for Defence, Home Affairs, and State Security (Heleta, 2017; TimesLIVE, 2019; South Africa, 2019; DefenceWeb, 2020a).

The current application of conventional methods of border safeguarding, control, and monitoring, such as foot and vehicular patrols, and fixed observation posts could be regarded as inadequate and ineffective in curbing the scourge of illegal cross-border activities along South Africa's international land borders. Considering this background, the researcher is of a view that embracing the full utilisation of space technology to safeguard, monitor and control South Africa's international land borders could be a solution to the current challenges faced by border authorities. The adoption of and integration of space technology such as satellites, together with Unmanned Aerial Vehicles (UAVs), and remote sensors to safeguard, control and monitor

national territories is increasingly gaining global recognition. Although public sector entities, such as the South African National Defence Forces (SANDF) and the South African Police Service (SAPS), play a central role in the provision of border security in South Africa, they might not have the requisite capacity to invent, develop or acquire the necessary space technology for application in border security.

Given the above, this research sought to examine how space technology could be employed to address land border security challenges in South Africa. The research further sought to explore the opportunities of forming partnerships between public sector institutions responsible for border security in South Africa, the private space technology sector, and other private interests affected by border security challenges to address the country's land border security challenges through the application of space technologies. This research could contribute to the body of knowledge required to enhance the capabilities of the South African border security authorities to safeguard, control and monitor the country's international borders through the application of space technology and through effective partnerships between South Africa's border security authorities and the private space technology industry.

1.3 Conceptual clarification

Theoretical concepts provide meaning to a research project (Denscombe, 2002). Therefore, the literature for this research was collected in line with the theoretical concepts clarified in the following discussion.

1.3.1 Border security

Border security refers to the mechanisms employed by a state to ensure the security of national borders and the legal regulation of the entry and exit of persons and goods. It further ensures that the diverse needs of the host nation are achieved (Minnaar, 2001; Moshen, Mohammad & Mahdi, 2015). Therefore, border security is those sets of proactive and reactive measures of preventing or detecting security threats and risks before they approach a nation's territory. Border security measures include inspections

and screening, the control of cross-border movements of people, and border patrols (Mahlangu & Obioha, 2015; Okumu, 2016).

1.3.2 Space technology

Space technology can be defined as technology developed by space scientists or the aerospace industry for application in spaceflight, satellites, or space exploration (NASA, 2019). It mainly refers to technologies that enable satellite earth observations, satellite positioning, and satellite communications. Spacecraft, aircraft and UAVs are some of the technologies and instruments of space technology. Technologies such as the ones used in weather forecasting, global positioning systems, remote sensing, communications systems, and satellite television are all features of space technology (United Nations Office for Outer Space Affairs, 2012; South Africa, 2020; NASA, 2020).

1.3.3 Public-private partnerships

Public-private partnerships (PPPs) refer to cooperative arrangements between two or more public and private entities to design, finance, build, and operate projects (Linder, 1999; Klijn & Teisman, 2002). Farlam (2005) also defines a PPP as a contract between a public and private institution where the private institution assumes substantial financial, technical, and operational risk for the project. In addition, Greemsy and Lewis (2002) state that a PPP consists of long-term contractual agreements entered between a public entity and a private partner for the purpose of constructing or managing a public sector infrastructure facility by a private partner. A long-term contractual agreement could also entail the provisioning of services by the private partners on behalf of a public entity.

1.4 Aim of the research

The aim of this research was to examine the practicability of employing space technology to address border security challenges on the entire South African land borders. This research further sought to explore the opportunities of forming effective

partnerships between the public sector, the private space technology sector, and other private interests affected by border security challenges to address land border security challenges in South Africa through the application of space technology.

1.5 Objectives of the research

The research explored the opportunities and challenges of forming partnerships between the public border security sector and the private space technology industry to enhance border security through the application of space technology in South Africa. Therefore, the objectives of this research are:

1) To examine the nature of border security threats and risks in South Africa;

2) To identify the challenges of controlling and monitoring South Africa's land borders;

3) To explore the practicability of employing space technologies for enhancing land border security in South Africa;

4) To explore the role the private space technology industry, together with the public border security sector, could play in enhancing land border security in South Africa; and

5) To suggest a policy framework for enhancing land border security in South Africa through effective partnerships between the public border security sector and the private space technology industry.

1.6 Research questions

The research sought to answer the following research questions:

1) What are the current threats and risks to border security in South Africa?

2) What are the current challenges of monitoring and controlling land borders in South Africa?

3) To what extent can space technology be applied to enhance land border security in South Africa?

4) To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

1.7 Significance of the research

Denscombe (2002) asserts that for research to be considered good, it should be able to contribute to existing knowledge and address real issues. It should also be relevant to contemporary issues, and further satisfy the researcher's personal agenda. Consequently, the researcher is of a view that the research outputs have the potential to contribute immensely to resolving the problem of controlling and monitoring the land borders and enhancing rural safety in South Africa through effective PPPs and the application of space technology.

This research was driven by the lack of or inadequate research in the area of space technology and border security in the South African context; and the lack of recognition of the role the private space technology sector can play in enhancing land border security in South Africa. Considering this, the researcher holds the view that this research will contribute to the theoretical discussions and the practical application of space technology to enhance border security in South Africa.

This particular research will also contribute to the theoretical discussion and practical application of partnerships between public institutions responsible for border security and the space technology sector in South Africa. Therefore, the specific outputs of the research were:

1) The completion of two conference papers by the researcher before submitting the thesis for examination;

2) Participation in one local and one international conference on border security and space technology;

3) Participation in a series of workshops to discuss the findings of the research with the border security authorities in South Africa;

4) Participation in border security strategy formulation engagements with South African borders security authorities; and

5) The completion of two peer-reviewed journal articles co-authored with the supervisor of this doctoral thesis.

1.8 Scope of the research

This research was limited in terms of the focus of the research and the research sample. Firstly, in terms of the focus, this research only focused on selected land border areas in South Africa and excluded the aviation and maritime borders. Secondly, the research focused on a purposively selected and a minimal sample of subject specialists in the field of border security and space technology.

1.9 Rationale for the use of PPPs to enhance border security through space technology

The management of international migration and the security risks related thereto has become a topical subject globally. Migration across the globe is triggered by factors such economic conditions; social, political, cultural, environmental, health and education conditions; as well as the ease of transportation across international borders (Arcarazo & Wiesbrock, 2015; Rubinstein & Orgad, 2019).

Migration mainly occurs due to the push factors of lesser opportunities as experienced in a socio-economic situation in a particular country or area, and because of pull factors that exist in better-developed countries or areas (Thet, 2014). Therefore, international migration consists of the forced or voluntary movement of people from

countries within the same region or from other regions to seek better opportunities and conditions in the country or area of destination (Koch, 2013; Dassah, 2017; Hayes & Vermeulen, 2012).

Transnational criminal activities such as human smuggling and trafficking; stock and vehicle theft; terrorism; and the smuggling of goods, arms, and narcotics are some of the characteristics of international migration and South Africa is not immune to these criminal threats and risks (Anderson, 2008; Martin, 2018; Mahlangu, 2016). These criminal aspects of migration place greater responsibility on states to protect their citizens from these security threats and risks (Segell, 2005). Key role players in this regard are institutions responsible for intelligence, immigration, policing, anti-terrorism, agriculture, customs, and health.

Even though Baker (2010) argues that the threat of conventional war against South Africa is so minimal, to the extent that it can be discounted, this author together with Martin (2011) caution that South Africa needs to be prepared to address the possible threats of terrorism, crime, and social unrest. This has been evident in recent years where there has been an increase in violent crimes and social unrest, such as service delivery protests, and attacks on foreign nationals. Although there have not been any records of terrorist attacks in recent years, there are speculations that South Africa is used by terrorist organisations as a base for training and hosting terrorists. Moreover, with its strategic position in the African region, South Africa also serves as a major transit hub to connect countries across the world (United States Department of State, 2018; Mohlabeng, 2020).

Illegal border crossings and the level of transnational crimes such as human smuggling and trafficking, narcotics smuggling, and cross-border vehicle and stock theft are cause for concern, and they have been identified in several media reports in South Africa (*The Citizen*, 2018; TimesLIVE, 2018; *City Press*, 2019). Past studies revealed the growing state of this criminality, exacerbated by the vast and porous South African land borders. Variations in the border terrain; human and physical resource constraints; and poor coordination and execution of border security activities by state departments within the border environment render it difficult to effectively control and monitor South Africa's borders. Thus, the assets and the level of cooperation available

for safeguarding, monitoring, and controlling South Africa's land borders are inadequate; hence, resulting in an unfavourable force-to-space ratio (Anderson, 2008).

In light of the discussions above, there is an absence of scholarly research on the feasibility of applying space technology to enhance land border security in South Africa. There is also an absence of scholarly research on the opportunities to foster partnerships among public sector entities responsible for border security in South Africa, the private space technology industry, and other private interests to enhance land border security in the country through the application of space-based technology. This is despite the global recognition these two aspects are receiving. Therefore, the current situation in the South African land border environment renders it crucial for the government to explore alternative means of ensuring effective border security.

Considering the global recognition of space technology as a valuable tool in enhancing border security and the important role the private sector is playing in the provision of critical public infrastructure and services, employing space technology through solid partnerships between the state and the private space technology industry could be of value in addressing the current border security challenges in South Africa. As mentioned by Kawakubo (2017), the state on its own cannot manage emerging security challenges such as organised crime. These sentiments are echoed by Busch and Givens (2012) when they emphasise the vital and growing role of PPPs in homeland security matters. These authors further state that PPPs can enhance aspects of resource utilisation, specialisation, and technological innovation. Similarly, Clark, Cordes and Roberts (2006) mention that although it is acknowledged that the state plays a central role in issues of homeland security, it could be enhanced through significant participation by both national and local governments, and the private sector.

In view of the above discussion, it can be argued that state institutions do not have the necessary resources and expertise to access space technology for enhancing border security in South Africa. Moreover, the task of securing a country's borders is an extensive and daunting operation that cannot be accomplished by public sector institutions alone. Therefore, effective collaborations through suitable partnerships between South Africa's border security authorities, the private space technology industry, and other private interests has become essential in addressing security

challenges on the country's land borders. This, amid increasing global recognition that space technology plays a significant role in monitoring and controlling national territories as it offers more flexibility and mobility (Gadda & Patil, 2013; Motlagh, Bagaa & Taleb, 2017; Liu, Liu, Shi, Wu & Chen, 2019).

The main objectives of utilising space technology in various aspects of national security would be to optimise border surveillance and control, improve intelligence gathering and the verification of information, and further facilitate easy access to thinly populated regions (Pedrozo, 2017; Kawakubo, 2017; Union Public Service Commission, 2019). Considering this, the private space technology industry possesses the necessary capability to provide technology, products, and service solutions necessary for enhancing land border security. Therefore, employing space technology, through suitable and effective PPP models, could provide an operational advantage that would significantly enhance the efficiency and effectiveness of land border security measures in South Africa (Anderson, 2008).

1.10 Delimitation of the research

Simon and Goes (2013) define delimitation as those factors that limit the scope and define the boundaries of a research topic. In addition, Leedy and Ormrod (2005) define delimitation as activities intended in the research question but omitted from the actual research. As previously stated, the focus of this research was only on land border security in selected provinces in South Africa. The selected provinces and land borders were the Free State-Lesotho; Mpumalanga-Mozambique; KwaZulu-Natal-Mozambique; and the Limpopo-Zimbabwe land borders. These land borders are said to be the most porous and experience higher cross-border crimes between South Africa and those neighbouring countries (Martin, 2011; Maluleke & Dlamini, 2019). The researcher excluded maritime and aviation borders. Moreover, the participants who were proposed to take part in the research were senior officers from the South African National Defence Force (SANDF) and the South African Police Service (SAPS). These institutions are directly responsible for safeguarding, controlling and monitoring the land borders. Although the Department of Home Affairs (DHA) is mandated to manage human migration in South Africa, it is currently not responsible for borderline safeguarding and policing. Thus, it was excluded from this study.

Other secondary role players, such as the Department of Agriculture Land Reform and Rural Development (DALRRD), the South African Revenue Services (SARS) and the Department of Health (DOH), were also excluded from the research. Therefore, the results of the research cannot be generalised to other state departments that form part of the border management in South Africa.

Regrettably, the researcher's request to interview participants from the SANDF was declined by the SANDF, as per **Annexure A** of this research. The research did however include seasoned subject specialists in the field of border security and space technology and also analysed documentary sources related to the functions of the SANDF in the border security environment.

1.11 Structure of the thesis

This research is divided into nine chapters, as briefly discussed below:

1.11.1 Chapter 1: General orientation to the topic and thesis

This chapter discussed the introduction, the background to the research, the problem statement, the research objectives, and the research questions. Therefore, this chapter presented the conceptual framework that underpinned this research.

1.11.2 Chapter 2: Border security in the context of South Africa

This chapter discussed the general theories of border security. Moreover, the chapter explored illegal migration trends in selected countries and the extent of illegal migration in South Africa. This chapter also focused on the general approaches to border security in the country. It examined the legislative framework and institutional arrangements applicable to border security in South Africa. Moreover, the chapter focused on the challenges of illegal migration borders and the implications of poor and ineffective border control measures.

1.11.3 Chapter 3: Space technology and border security

In this chapter, the researcher focused on the general theories of space technology and the application of space technology for civilian and commercial purposes. It also examined space technology in developed and developing countries. Moreover, the researcher explored various space-based technologies, which could be developed or acquired to enhance border security in South Africa.

1.11.4 Chapter 4: Public-private partnerships

In this chapter, the researcher reviewed literature using various sources of secondary data. The review of literature focused on theories underpinning PPPs; the application of various PPP models intercontinentally and continentally; and the application of PPPs in space and homeland security projects.

1.11.5 Chapter 5: Research methodology

In this chapter, the researcher discussed the research methodology applied in this research. Various aspects were discussed, such as the research design and approach, the target population, the sampling methods, data collection and analytical methods, issues of trustworthiness, and ethical considerations. It also discussed the value this research could hold for the existing body of knowledge, and the challenges encountered by the researcher during this research.

1.11.6 Chapter 6: Presentation of the research findings

In this chapter, the researcher presented the findings of the semi-structured interviews. The researcher used thematic analysis to identify key subthemes, which emerged against predetermined theses, and further offered the varying meanings the research participants attached to the specific line of enquiry.

1.11.7 Chapter 7: Interpretation of the research findings

This chapter provided a detailed discussion and interpretation of the research findings against the backdrop of the literature review and the information gathered through the semi-structured interviews. The researcher interpreted the views of the research participants and the information contained in documentary sources. The researcher also weighed the views of the participants against the available literature, as presented in Chapters 2, 3 and 4 of this research.

1.11.8 Chapter 8: Summary of research findings, conclusion, and recommendations

This chapter presented the summary of the research findings, the conclusions reached from this research, and the recommendations from this research. Thus, this chapter offered recommendations and conclusions on the opportunities and challenges of enhancing border security through the application of space technology, and the PPPs necessary to achieve this objective in South Africa.

1.12 Chapter summary

In this chapter, the researcher discussed in detail the problem statement of this research, the scope of this research, and the aims of this research. This chapter also discussed the key theoretical concepts aligned to this research, the value of the research, as well as the challenges encountered during the research. In the next chapter, the researcher will explore literature on migration, borderline security, space technology, and PPPs.

CHAPTER 2

BORDER SECURITY IN THE CONTEXT OF SOUTH AFRICA

2.1 Introduction

Migration is one of many factors that shape a country's economy, politics, societal setting, and ecology (Nkhoma, 2012). Considering this, one of the biggest security challenges facing many countries in the world is the task of securing international borders and protecting citizens from organised crimes and terrorist attacks. With wars being less frequent in recent times, than in previous eras, the provision of effective border security and defence has become a national security priority for many countries (Segell, 2005). Considering this, border defence is normally executed by armed forces who are equipped with military equipment such as tanks, warships and aircrafts to protect a state against wars and invasions. On the other hand, border security is mainly the task of para-military forces or police, executed for the protection of citizens against organised criminal activities, the outbreak of diseases, and terrorism; also, for the prevention of illegal migration, human and drug trafficking, and money laundering (Adelman, 2002; Pickering, 2004; Van Rooyen & Leenen, 2011).

Border defence and security mandates require the involvement of various government departments and the employment of a combination of legal and institutional instruments, methods, resources, and equipment. Thus, the state departments involved in border security and defence would be the military, immigration services, agriculture, health and disease control services, customs, policing, and counterterrorism. In addition, assets for border defence and security would include border post infrastructure; vessels and vehicles; surveillance equipment; and other border security technologies (Adelman, 2002; Pickering, 2004; Jensen, 2004; Frowd, 2015).

This chapter seeks to explore border management approaches in South Africa by examining the theoretical concepts of border security; the nature of the South African border landscape; and the management of border security in South Africa, which will

cover both the institutional and legal frameworks. In addition, the chapter will explore resources for border security and control in South Africa; the challenges of border security in South Africa; and the implications of poor border security.

2.2 Theories of border security

The subject of borders and border security has gained popularity as a scholarly topic due to the significant role borders play in defining and making visible states, and the role borders play in promoting state sovereignty and national security (Caparini & Marenin, 2006; Mahlangu & Obioha, 2015). In this section, the researcher explores what borders are, and further explores the definition of border security.

2.2.1 Definition of border

The literature on borders has not only focused on the roles of borders in defining states and cultures, but it has also focused on borders as areas of security and political significance. Scholars, depending on their various disciplines, tend to focus on their areas of interest when it comes to the topic of border security. For example, cultural scholars are likely to focus on the way in which social and cultural identities are formed with the shifting of borders and simultaneously, how borders are maintained by cultural and ethnic differences. Historians, on the other hand, will focus on the link between borders, identities, territories, and the sovereignty of nation states. Similarly, scholars of security will tend to focus on the security aspects of borders, where borders are regarded as spaces that require safeguarding and protection against external and other threats and risks. Lastly, scholars in the field of politics will focus on the way states exercise their authority over national borders and define how populations are managed using borders by determining who and what enters a nation's territory (Sassen, 1999; Salter, 2004; Miller & Hashmi 2001; Pickering & Weber, 2006).

It can also be argued that borders serve to include and exclude as states have monopolised the right to determine who and what can be granted legitimate territorial access. That is, those people who and goods that meet the requirements of entry into a country will be allowed entry. On the other hand, those people who and goods which

do not meet the requirements for entry, will be refused entry into a particular country (O'Dowd, 2001; Frowd, 2015).

The main purpose of borders is to provide states and their citizens with the necessary assurance of security against the ever-changing nature of transnational threats and risks. As such, borders have become targets to be subverted and avoided by persons with illegal and malicious intents. Additionally, borders serve to protect the social and economic interests of states. It is for this reason they are employed by states as resources, symbols of identity, barriers and bridges aimed at repelling foreign intrusions; neutralising competition; and protecting domestic trade. On the other hand, they are open to foreign workers with the requisite skills to contribute positively to local economies. Borders are not merely "lines in the sand", but well-constructed, networked, and cultural spaces enacted across territories, and a symbol of security among states (O'Dowd, 2001; Frowd, 2015). Against this background, Pickering and Weber (2006) highlight that in a world that is rapidly globalising, borders are taking new forms, shapes, and significance. Borders can be formed, shifted, strengthened, and deconstructed by a variety of actors, events, and even processes. Borders play a significant role in strengthening human belonging with geographical areas and cultural groups (Newman, 2006; Vollmer, 2019; Caparini & Marenin, 2006).

Historically, and today, borders continue to be areas of securitisation and lines that are real or imagined which divide two pieces of land, societies, or nations. When borders cut across two nations, they are considered as international borders, often defined from one point to another through various instruments including arbitration awards, treaties, or reports of established boundary commissions. Borders were created to offer protection to those who live within them from any form of threat. As with the initial thinking, borders are in place to protect one's own land and society, and to serve as a further measure of control and safety (Caparini, 2006; Vollmer, 2019).

Borders have however evolved to beyond geographical lines, and within societies, they are meant to protect. They have now shifted away from traditional physical barriers and fences within territorial limits to virtual borders in other territories through new border security technologies such as Advance Passenger Processing (APP) and regional and international border security collaborations. Airports have also become

borders, kilometres away from a nation's boundaries. Even with the concept of free-trade areas, which seek to encourage cooperation between at least two countries for the sake of removing or reducing trade barriers, the relaxation of border controls has become more relevant to cross border movements of one's own citizens, particularly across internal borders, and with stringent control measures at external borders (Minnaar, 2001; Walters, 2006; Squire, 2011; Okumu, 2016).

From a legal point of view, international borders define the boundaries in which states can exercise their political and legal jurisdiction. They determine the end of a specific country's political and legal jurisdiction and define the beginning of the next country's political and legal jurisdiction. Thus, legitimate government functions and responsibilities cannot be adequately discharged in the absence of clear and well-defined political and legal boundaries. Considering this, states have always been concerned about borders and have a desire to extend their authority, functions, and responsibilities throughout their entire territory.

The inability of states to achieve these objectives, coupled with ineffective and weak political structures and institutions, has often resulted in instability and conflict within state territories. Conversely, the ability to create stable national borders and the ability to exercise control within national territories contribute to the stability of governments and states. International borders and the control measures associated with them should not be viewed as inhibitors of the cross-border movement of both people and goods, but rather as measures implemented to regulate an orderly and legal flow of such movements. All these prevailing factors, place responsibility on governments to put in place effective and efficient border control and management measures that will support social, security and economic initiatives (Minnaar, 2001; Ikome, 2012; Laremont, 2006; Okumu, 2016).

2.2.2 Concept of border security

The issue of border security has assumed heightened significance and importance due to an increase in the rate of illegal migration and transnational criminal activities, especially since the end of the Cold War. Globalisation and advancements in

telecommunication, transportation and technology have made it easier for people, illegal migrants, trafficked persons, and criminal networks to move across the world with ease. Moreover, massive migration flows due to conflict, wars, political intolerance, and poor environmental and economic conditions have meant that host countries need to be prepared to manage and control these migration flows. It has further meant that governments need to consider national security as their main priority. In addition, these developments have meant that the control and detection of illegal migration and transnational crimes will mainly be a border security function (Caparini & Marenin, 2006; Segell, 2005; Lynch & Hadjimatheou, 2012; Akinyemi, 2013; Okumu, 2016).

African countries, South Africa included, are not spared this phenomenon, and they are overwhelmed by a variety of traditional and non-traditional security threats and risks. This situation has compelled African countries, institutions, and their people to rethink and assess the nature of security along the lines of whom and what needs to be secured and protected (Solomon, 2015; Erasmus, 2020). Cowen (2002) and Andreas (2003) advance that the ever-growing interdependence of states, cultures, populations and economies as a result of the ease of cross-border mobility, advancements in technology, and the demilitarisation of international borders have impacted on how states control the movement of persons, capital and information flows, and how the integrity of state borders is maintained. Similarly, with the emergence of legal economies, these authors argue that there is a parallel emergence of illegal economies through illegal activities executed by transnational and organised criminals.

Globalisation has allowed criminal networks to move across borders with relative ease and to continue with their illegal activities and businesses with greater impunity at the expense of socio-economic development and the security of people and property. Border security is a critical factor of border management and an issue of concern for most, if not all, governments as nothing can be realised by them if there is a feeling of insecurity among their citizens. Furthermore, should a country's borders be insecure, it will create difficulties for such a country to achieve its social and economic development objectives. Consequently, fear, hunger, poverty, and diseases will dominate these countries. Besides, states receive international recognition and are rated accordingly when they can maintain their borders, secure their territories, and

offer protection to their citizens. The global positioning of a country further plays a critical role in determining the vulnerability of that country to cross-border threats and risks (Akinyemi, 2013; Okumu, 2016).

Border security can be attributed to a state's ability to deter any form of attack, or its ability to defend and protect its interests from both internal and external threats (Wolfer, 1962; Bock & Berkowitz, 1968). There is also a direct link between border security and national security, where the latter is a critical characteristic of all successful nations since national security cannot be achieved in the absence of effective border security and control (Geldenhuys, 2019). National security strategies in many countries emphasise the notion and importance of secure and peaceful national borders. Regrettably, only a few African countries have well formulated border security strategies. This situation differs from other regions in the world, and it has led to an increase in a variety of threats and risks, such as cross-border crimes in Africa. The lack of effective border management and the presence of ineffective border security approaches in Africa are attributed to factors such as the lack of institutional mechanisms, inadequate interdepartmental cooperation, ineffective early warning systems for intelligence, and the absence of proper border demarcations (Kwesi, 2012; Khadiagala, 2010; Martin, 2011).

The increase in the movement of person and commercial goods across borders has put enormous pressure on the border control systems of many countries. These realities and considering the fact that international borders are managed by at least two countries, have meant that countries, and African countries in particular, have to implement effective measures and systems of border management and control to minimise cross-border tensions; minimise organised and syndicated criminal and human trafficking activities; improve joint law enforcement efforts; and improve border surveillance efforts. Moreover, these realities provide an opportunity for nations to work collaboratively to address issues of common interest; manage borders in a manner that minimises trade barriers and improves cross-border trade; ensure the exchange of critical infrastructure; and secure the passage of people and goods in a manner that promotes the spirit of regional and continental integration. However, approaches to border security, that is, the views on what needs to be done and how it needs to be done, will differ from one border area to another, and will further shape

the level of cross-border collaboration required to achieve the desired results (Okumu, 2016).

Given the above, border security can be described as a set of proactive and protective measures instituted by governments through several border security agencies for the purpose of preventing or detecting security threats and risks before they approach a nation's territory. Border security measures consist of measures applied by border security agencies to deter, prevent, or detect a variety of border security threats such as illegal migration, illegal smuggling of persons and illicit goods, narcotics and drugs; smuggling of firearms, ammunition, or vehicles; or threats of terrorism and insurgency. These measures include activities undertaken by various border security agencies such as enhancing inspections and screening to ensure that no harmful products and humans enter a country's boundaries; internal enforcement of migration laws; controlling cross-border movements of people; and border patrols by border guards or the military. Border security activities also include processes of enhancing the capacity of border security agencies and systems that contribute to effective border security (Mahlangu & Obioha, 2015; Okumu, 2016).

As much as borders have shifted in terms of their definition, shape and location, border security functions have also shifted away from states' territorial limits to dispersed and diverse sites located far beyond geopolitical borderlines, as well as inside the societies they are meant to offer security to. This is amid the realisation that border control measures cannot be limited to a fixed line on a map. Thus, the concept of offshore border control has become a new doctrine for some countries with the purpose of checking potential visitors before they reach a country's shores (Balibar, 2004; Côté-Boucher, 2008; Squire, 2011).

The discussion above has shown a direct link between global migration, illegal migration, transnational crimes, and border security. Considering the views of Solomon (2015), African countries, institutions and people are compelled to rethink and assess the nature of security, along the lines of whom and what needs to be secured. It can also further be deduced from the earlier discussion that border security is aimed at managing threats that are brought about by human migration and the movement of goods. Considering this, South Africa, which is one of the most

developed countries in Africa, and a preferred point of destination for many around the continent and beyond, is not immune to the security challenges that accompany globalisation and the increased movement of persons and goods. Thus, it can be deduced that global migration and security developments in the international arena have a bearing on how South Africa responds to emerging global security threats. Moreover, it could be argued that there could be other unique local factors, which might require an approach uniquely tailored for the South African border security environment, its issues, and its challenges.

2.3 Socio-technical aspects of border security

The world, because of transnational crimes and threats to national security, has observed costly and controversial military interventions; hardened migration control policies and practices; reinforcements of aviation and airport security; elevated surveillance and emphasis on border management; and the introduction of biometric systems to identify citizens. There has also been heightened focus on the training and development of most countries' security personnel. The African continent, with its emerging global security challenges as a result of globalisation, is increasingly expanding its knowledge of population and territorial issues, and its relations continentally and internationally; and turning to new technologies for the management of its international borders (Andreas, 2003; Frowd, 2015).

Border security and control measures are dependent on several factors, which are known as socio-technical factors. The socio-technical system in border security consists of both human and non-human elements interacting with each other in the provisioning of effective border security in a country. The success of border security is mainly dependent on the effective management and control of these two factors, and greater interactions between these two factors. It is also worth mentioning that one factor is no more important than the other is, but they seek to complement each other for the effective provisioning of border security and control (Duggan & Hinman-Sweeney, 2009; Frowd, 2015). Thus, the notion of socio-technical systems is mainly attributed to the interdependence of both internal and external factors.

With internal factors, self-regulating groups have a dependency on one another to achieve the desired outputs from the entire system. It can also not be ignored that the entire enterprise also interacts with its external environment and is dependent on external suppliers for its survival; moreover, it has a client who relies on its services. It should also be acknowledged that the socio-technical system is vulnerable to disruptions and disturbances, which could cause instabilities. In addition, the technical factor is often programmed and easier to predict than the human factor. In the border security environment, an example would be the manipulation of border control systems and process by officials through corrupt behaviour (Brostoff & Sasse, 2001; Mitnick & Simon, 2003; Foster, 2018).

2.3.1 Governance structures, processes, and procedures for border security

Border security governance refers to all deliberate sets of practices, provisions, and principles necessary to give effect to border security processes and procedures geared towards achieving national security objectives. Border security governance often consists of laws, policies, management structures, cooperation mechanisms, and procedures necessary to give effect to the mandate of border security and control. Since the provision of national security is a state competency, states play a leading role in the provision of border security. States play a critical role in neutralising internal and external threats that might be caused by existing and emerging vulnerabilities and threats that might arise as a result of the state's inability to secure its borders (Geddes, 2012; Fukuyama, 2013; Seda, 2015).

Border security is fundamentally a political tool. The political element of a country is responsible for prioritising, shaping, and limiting border security functions. It is also responsible for assigning functions of border security, together with the establishment of all the applicable laws, international treaties, and oversight mechanisms to ensure that the border security system functions properly (Schwan, 2012). Considering this, states will articulate the necessary legal framework within the state and across other states through local and international relations protocols respectively. States are also responsible for the distribution of governmental powers and responsibilities to border security actors. In addition, there should be measures employed by states to assess the

implementation of applicable legal frameworks and the performance of delegated border security actors. In the South African context, Parliamentary Portfolio Committees and the Justice, Crime Prevention and Security (JCPS) cluster are monitoring, and evaluation mechanisms employed by the state to exercise accountability and transparency; establish the rule of law; provide stewardship on government projects; and transform state institutions (Maxwell & Dawes, 2009; Schwan, 2012; South Africa, 2020).

Border security governance structures include a variety of actors across varying sectors of government such as the military, the police, migration and customs services. These structures also include bureaucrats, politicians, and clandestine actors such as transnational criminals and their networks. The latter play a significant role in shaping border security approaches in that border security processes and practices are usually a response to emerging transnational security threat that are caused by criminal elements. These governance structures extend beyond a nation's territory to include regional and international collaboration, treaties, and memoranda of understanding between countries. It is, however, to be acknowledged that the bulk of these collaborations occur at a technical level where liaisons on security matters give effect and shape a specific security agenda (Kunz, Lavenex & Panizzon, 2011; Schwan, 2012). Other governance structures of border security include community and civil society organisations, which are often directly or indirectly affected by border security threats and government border security policy positions. The academic community is another key role player; they play a significant role in developing and shaping border security knowledge (Kunz, Lavenex & Panizzon, 2011; Schwan, 2012).

Border security and control in South Africa is characterised by extensive legislative frameworks, which will be discussed in detail later in this chapter. To be implementable, these legislative frameworks must be complemented by a set of regulations and operating procedures which, in most cases, are developed by individual departments without due consideration to other departments within the same border environment. Border management processes, such as the Integrated Border Management Strategy (IBMS) are part of the border governance approach that drives border security operations in South Africa. The IBMS seeks to integrate all border security functions in South Africa. This integrated approach is achieved

through several national and provincial border security structures, such as the National Joint Operations and Intelligence Structure (NATJOINTS) and the Provincial Joint Operations and Intelligence Structure (PROVJOINTS). The integration of border processes is also cascaded down to operational units at border posts and at the borderline. These include various committees, such as the Border Safeguarding Forums (BSF); Port Management Committees (PMC); Joint Operations Committees (JOC); and Venue Operational Centres (VOC) (UNODC, 2010; RSA, 2013; DHA, 2017; PMG, 2015).

Moreover, the South African border security architecture consists of technical process flows, which define each department's responsibility in executing the border security mandate at the actual borderline and border post. Technical process flow also defines how each department should carry out its mandate in relation to other border security processes. Considering the large number of state departments operating in the border environment in South Africa, and apart from the challenges of fragmented governance structures, technical processes are a thorny issue because state departments continue to work in silos. In other instances, one state department will not know what the other department is doing, even though the specific activity executed by one department will likely impact on the operations of the other affected department.

2.3.2 The human factor of border security

Border security and control is not only about facilitating legitimate human migration, but it is also about exercising control over an array of security factors, including terrorism, drug smuggling and the movement if illicit goods. To manage these various aspects of border security and control in the South African context, there are various institutions involved in border security and control. Each of these departments has assigned officials to execute the legislative and policy framework applicable to that specific department. For example, soldiers are mandated to execute the border safeguarding function and to manage borderline security challenges in South Africa. Similarly, police officials are tasked with policing, mainly at the designated ports of entry and within the ten-kilometre radius of designated border posts in South Africa. Immigration officers are mandated to execute the function of admitting and departing

persons into and out of South Africa respectively; and immigration inspectors are tasked with the tracing and detention of illegal migrants within the country. Other officials include customs officials who are mandated to execute applicable customs and excise regimes at ports of entry (Caparini & Marenin, 2006; Schwan, 2012; Frowd, 2015; Mahlangu & Obioha, 2015).

Other border security functions in South Africa include the management of diseases and the enforcement of agricultural and environmental factors at selected ports of entry through the health and agriculture departments respectively. Moreover, there are local and international organisations and forums involved in various aspects of border security and control in South Africa, which will be discussed further in this chapter. Some of the border security functions have been outsourced to private companies. This paradigm shift from a state-only approach to border security allows for a broader cooperation on border security and management issues; provides opportunities for bilateral technical assistance; and offer opportunities for greater information-sharing at the local and international level (Shearing & Wood, 2000; Frowd, 2015).

Border controls have also been extended beyond the South African borders. Most of the state departments involved in border security and control at the local level are also represented at South African missions abroad, such as police liaison officers; defence advisors; secretaries for migration and civic services; and intelligence coordinating officers. The deployment of officials abroad allows for intelligence gathering, security assessments, and the provision of security advisories to South African authorities at both the international and local level. The externalisation of South African borders also allows these law enforcement personnel to conduct the pre-screening of persons wishing to visit South Africa for a variety of reasons, such as for leisure, business, and medical purposes (International Civil Aviation Authority, 2014; Campbell, 2019). Thus, as stipulated by Frowd (2015), this socio-technical space is characterised by meetings, overlapping activities and interactions between different security professionals in the border security environment.

2.3.3 Non-human factors of border security

Another factor of border security is the non-human factor that consists of various physical or material structures or objects, which shape both the security challenges and responses to them. Given this, the first example of a non-human factor of border security is the border landscape which Aradau (2010) regards as a geographical factor that shapes a country's security problems. Thus, the terrain and typology in a border area will determine how difficult or easy it will be for elements, who want to circumvent them, to do so. It will also define how easy or difficult it will be for border security authorities to exercise effective control over the border area, and to determine what type of equipment or resources will be required to monitor and control different parts of the border area. Although South Africa's territorial boundaries were imposed by colonial imperialist, as in the rest of Africa, natural elements such as the Limpopo, Caledon and Orange Rivers serve as natural boundaries at the South Africa-Zimbabwe, the South Africa-Lesotho, and the South Africa-Namibia borders respectively. The densely populated border terrain on the South Africa-Botswana and South Africa-Namibia borders, for example, also serve as natural barriers.

Another non-human factor of security is border security infrastructure. Considering this, South Africa has in recent years and especially in preparation for the 2010 Federation of International Football Association (FIFA) Soccer World Cup introduced several interventions to enhance border security and control. The focus has not only been on enhancing border patrols, but also on improving all aspects of border security, including border post infrastructure and the technological aspects of it; the recruitment and training of border officials; and the acquisition and deployment of physical resources within the border environment. Border posts exist as part of the broader border security infrastructure, serving the same purposes as a border fence or other material designed to serve as a physical barrier between South Africa and its neighbouring countries. Within the border posts, there are other physical resources such as office spaces; passenger and goods processing facilities; Close Circuit Television (CCTV) cameras; access control measures; and Information Technology (IT) hardware. These are all part of a network of non-human systems and processes necessary for enhancing border security in South Africa (Brand South Africa, 2010; PMG, 2013).

The upgrading of border posts, which is an ongoing process, has been one of the interventions aimed at easing the movement of persons and goods across the borders of South Africa. Plans are also underway to redevelop six major commercial land border posts to a One-Stop-Border-Post (OSBP) in South Africa, which include the Beitbridge, Lebombo, Oshoek, Ficksburg Bridge, Maseru Bridge, and Kopfontein border posts. The purpose of the redevelopment of border posts is to improve the flow of traffic of persons and goods across South African ports, and to enhance the security of migration control processes. This has been an emulative process to align South Africa's commercial border posts with international trends and practices considering that most, if not all border posts in South Africa, were developed during the apartheid era with the main purpose of excessively restricting the movement of persons and good across the borders. Thus, the redevelopment of the border posts is a modernisation and development process, which seeks to enhance the efficiency and effectiveness of the border security process (PMG, 2013; DHA, 2018; TimesLIVE, 2020).

On the technological side, IT systems are in place in the border environment to aid the human factor in administering border security processes. The DHA has also improved its movement control systems by moving away from the legacy systems of recording the movement of persons into and out of the country. The enhanced Movement Control System (eMCS) was introduced to provide for a more enhanced and efficient way of managing the movement of persons into and out of the country. As borders moved beyond a nation's territory, the system of border control was enhanced to include Advance Passenger Processing (APP), which is a system used by a border security collective to manage the flow of persons into the country. This system allows for the pre-clearance of a traveller when presenting him/herself to board a commercial aircraft to travel abroad. Biometric identification systems have also been introduced by the DHA at selected key ports of entry in both the aviation, maritime, and land border modalities to enhance border security processes (PMG, 2013; IsiAfrica, 2010).

The visa regime is another non-human element employed by immigration services as a layer of security, which allows for pre-arrival screening. Plans are afoot to introduce an e-visa system in South Africa, which will allow for the centralisation of the visa adjudication process. Plans are also underway to introduce the Automated Biometric Identification System (ABIS), which will integrate all the systems managed by the

DHA. This system in important, as it will allow for the consolidation of databases and standalone systems and provide for a multi-modal biometric capability. Thus, the system will minimise migration-related fraud and facilitate information sharing across the Criminal Justice System (CJS) cluster (BusinessTech, 2018; IOL, 2018; PMG, 2019).

When it comes to the actual safeguarding of the borderline, resources needed include vehicles and surveillance equipment used by the army to safeguard and patrol the border area between South Africa and its neighbouring countries. In the maritime border environment, resources will include the vessels used by the navy, the police, and the environmental services to patrol the coastline, conduct surveillance, and enhance the security of territorial waters. Similarly, aircrafts, radars and satellite systems, and other surveillance technologies are deployed by the air force to monitor and safeguard the South African airspace. All these non-human elements and their application are necessary to ensure that foot, vehicle, aircraft and boat migration as well as other transnational crimes are well managed, and that the integrity of the national territory is enhanced and maintained (PMG, 2010; DefenceWeb, 2018b; DefenceWeb, 2020a).

Other tools for border security are those applicable to the movement of goods across South Africa's borders. They include customs and excise systems, such as cargo and luggage scanners; sniffer dogs; and IT systems employed by SARS to enforce and ensure compliance to the customs and excise regime. These are necessary to ensure that illicit goods, which could be harmful to the economy of the country, are intercepted and are not permitted to enter or depart from the country. These are complemented by non-human systems employed by the port health services to monitor and control human transmissible diseases, and the agricultural services, which look at diseases that may be caused by the movement of agricultural products. On the other hand, non-human resources are employed by the environmental services to enforce environmental laws and to protect South Africa's wildlife and endangered species (SARS, 2020).

Considering the extent of illegal migration and cross-border crimes experienced by South Africa (to be discussed in detail later in this chapter), the socio-technical

systems implemented by the country appear to be ineffective in dealing with the daily socio-economic and political pressures of migration, predominantly from neighbouring countries, and the growing levels of transnational crimes since the advent of democracy in 1994. It is however important to state that border surveillance strategies should always be subject to cost-benefit calculations, and cost factors should always be considered when considering border security measures (Koch, 2013; Cronje, 2016; DefenceWeb, 2020b).

2.4 South African land borders

This section of the study will explore the South African border landscape, examining the vastness of the country's international land borders with its neighbouring countries; the number of border posts shared with neighbouring countries; and the issues and challenges related to the South African border environment at each of the border areas with the neighbouring countries.

2.4.1 South African border environment

As a sovereign state, South Africa has international borders that are well recognised by at least 200 states. This implies that South Africa has the sovereign right to determine who and what enters or departs from its territory. It also reserves the right to set conditions for such entry and departure. Geographically, South Africa is approximately 1 219 090 square kilometres in size and has extensive international land borders of more than 4700 kilometres in length (World Atlas, 2019; DHA, 2017).

The map, in Figure 2.1 shows the positioning of South Africa in relation to its neighbouring countries. Each province in South Africa has an international airport. Furthermore, all coastal provinces, apart from the Northern Cape, have one or more maritime ports of entry. Moreover, the map shows that Lesotho is surrounded by South Africa through the Free State, KwaZulu-Natal, and the Eastern Cape provinces. It also shows that most of eSwatini is enclosed by South Africa by the KwaZulu-Natal and Mpumalanga provinces. The remaining portion of eSwatini is enclosed by Mozambique.

South Africa shares its international land borders with six neighbouring countries, namely: Botswana with a borderline of 1840 kilometres in length, Lesotho with the length of 909 kilometres, and Mozambique with a borderline of 491 kilometres. Other international land borders are with Namibia, eSwatini, and Zimbabwe with the length of those borders being 967 kilometres, 430, and 225 kilometres respectively. Apart from international land borders, South Africa boosts of a coastline of about 2800 kilometres in length, running from the Indian Ocean on the Mozambican sea border to the Atlantic Ocean on the Namibian sea border (World Atlas, 2019; DHA, 2017).

The total number of designated ports of entry into South Africa is 71, consisting of 53 international land border posts between the six neighbouring countries; eight international maritime ports of entry; and ten airports. The positioning of South Africa and its well-developed infrastructure, modern communication systems and international transportation hubs enhance international travel and allow for exceptional inter-continental and international connections. Moreover, South Africa is one of the preferred and major countries of destination, departure, and transit, particularly compared to other countries on the African continent. Considering this, there have been calls by various previous Ministers of Home Affairs to review the number of ports of entry in the country to improve the management of the remaining ports and the related risks (McMichael, 2012; DHA, 2017; Border Management Authority, 2015).

South Africa is equipped with sophisticated infrastructure, communication and network systems, and regional and international transport hubs, such as airports and harbours, which facilitate regional and international travel as opposed to many countries on the African continent. Moreover, the Southern part of Africa and South Africa in particular, occupy a strategic position for both sea and air travel to other continents such as Europe, Asia, and North and South America.

Figure 2.1: Map of South Africa

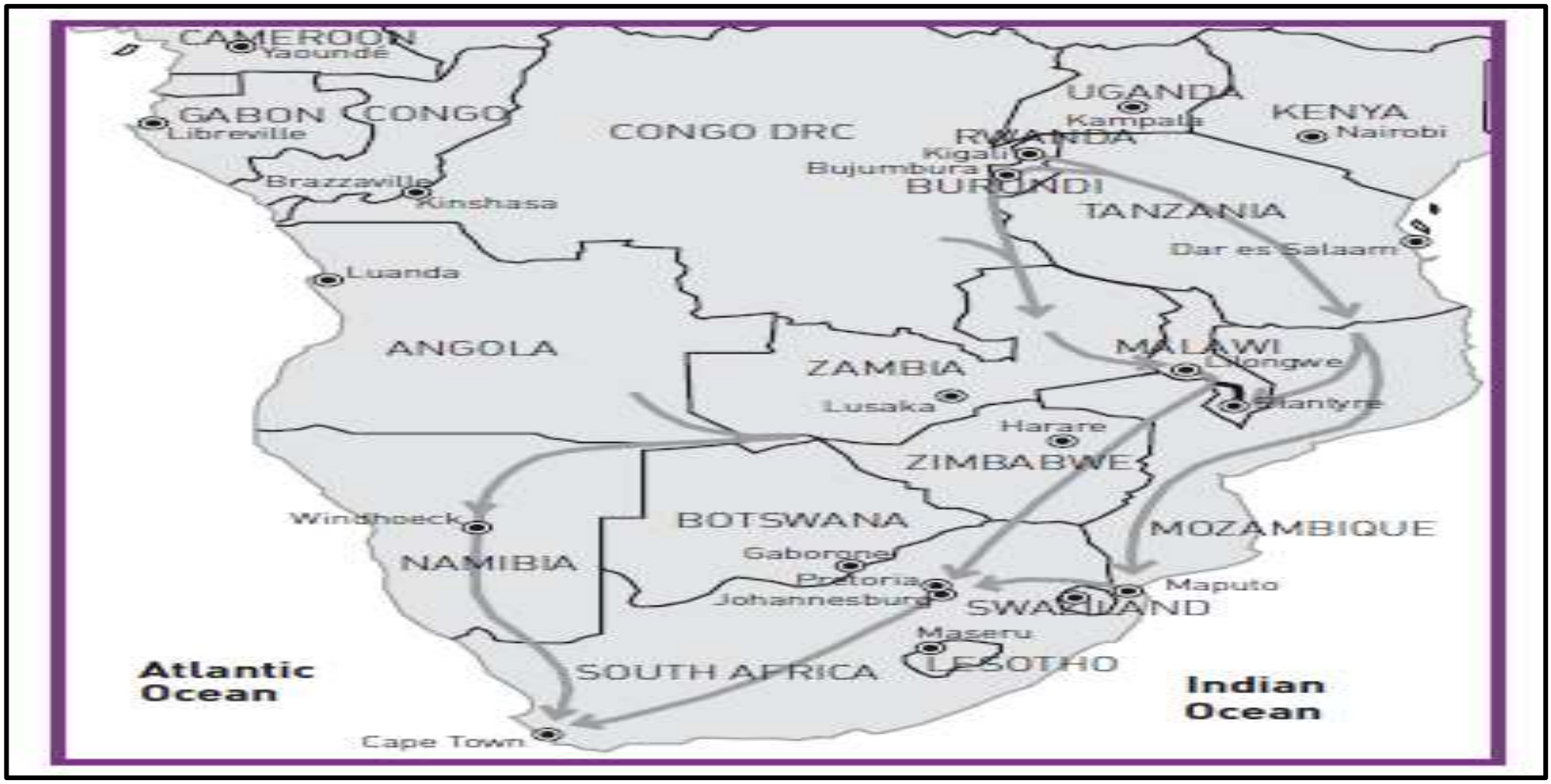
Source: Britannica (2020)

The strategic positioning of South Africa adds both economic opportunities and risks for transnational crimes. Due to this strategic positioning, South Africa has become a major point of transit, embarkation, and destination on the continent. On the other hand, it is a preferred destination for irregular migrants such as border jumpers, undocumented migrants and transnational criminals, and the associated criminal activities (Nsereko, 1997; DHA, 2017).

South Africa is also an important point of departure and transit route for transnational organised criminal networks involved in human trafficking and migrant smuggling. It can be seen from Figure 2.2 that the Botswana border is the least preferred border for illegal activities. This could be attributed to the political stability in the country, relative to other countries in the region. This factor becomes important for border security in South Africa (UNESCO, 2007).

Figure 2.2 not only shows the routes taken by migrants (including refugee populations) to reach South Africa, but also the routes commonly taken by regional and international human trafficking syndicates to smuggle migrants into the country. As discussed earlier in the socio-technical aspects of border security, transnational criminal elements tend to exploit weaknesses in a country's border security architecture and, should border security measures in neighbouring countries be weak, they are likely to affect border security in South Africa. The opposite is also true in that should border security measures in neighbouring countries be strong, they will be advantageous to border security in South Africa. It has also been stated that the border security function cannot be left to only one state. It requires close collaboration between two or more states. Thus, the implementation of effective border control measures in neighbouring countries will likely result in benefits to South Africa's border security efforts (IOM, 2003; UNODC, 2020).

Figure 2.2: Main continental routes into South Africa



Source: UNESCO (2020)

2.4.2 South Africa's international land borders

South Africa and its six neighbouring countries are separated by demarcated international land borders. To facilitate the movement of people and goods across these international land borders, there are border-crossing points designated for that purpose along the international land borders with the each of the six neighbouring countries. There are also international airports, which serve the purpose of a border between South Africa and the six neighbouring countries. However, the discussion to follow will only focus on international land borders and will exclude air and maritime international borders.

2.4.2.1 South Africa-Lesotho borders

The Kingdom of Lesotho is a small mountainous country with a population of approximately two million people. It is the only country, among the six countries, which is completely enclaved by South Africa. For Basotho to travel to other countries by road, they must travel through South Africa's territory. Historically, the Basotho people living in Lesotho and Sotho-speaking people living in South Africa, especially in the Free State province, are believed to be one nation and they share similar cultural practices and norms. Due to the colonial demarcation of the African continent, the Basotho tribe was divided into two groups, those living in Lesotho and those living in South Africa (Crush, 2013; Mahlangu & Obioha, 2015; Mahlangu, 2016; Mokoena & Balkaran, 2018).

The current borders between Lesotho and South Africa were established in 1869 through the Second Treaty of Aliwal North, signed by the British and the Boers of the Orange Free State, which deprived Lesotho of the western part of its territory and reduced it to half its original size. After the colonial separations, Basotho were not required to produce passports to enter South Africa, until 1963 (Viljoen & Wentzel, 2007; Kapa, 2015).

In terms of border crossing points, there are 14 border posts between South Africa and Lesotho. Eight of those are in the Free State province of South Africa; four in the Eastern Cape province of South Africa; and two in the KwaZulu-Natal province of South Africa. The two major ports of entry between the two countries are the Maseru and the Ficksburg border posts. The borders between South Africa and Lesotho are characterised by illegal migration. Apart from the illegal migration occurring at the established border posts through corruption and other means of circumventing border processes, it is also easy for undocumented migrants to jump the fence or use the river to cross to and from Lesotho without any hindrances. Those who cross into South Africa usually go to the neighbouring towns to shop or to visit friends and families, and they immediately return to Lesotho. Others would migrate to big cities in South Africa such as Johannesburg for employment better economic opportunities. Also, Lesotho is known as a one of the countries in Africa where dagga is cultivated. The dagga often finds its way into South Africa through illegal means (Crush, 2005; Mahlangu & Obioha, 2015; Mahlangu, 2016).

2.4.2.2 South Africa-Mozambique borders

There are four border posts between South Africa and Mozambique. Two of these border posts are situated in the Limpopo province of South Africa, one in the KwaZulu-Natal province, and one in the Mpumalanga province. As is the case with other South African borders, the South Africa-Mozambique borders face challenges of illegal migration and cross border crimes, such as vehicle theft. These activities are exacerbated by the absence of a borderline fence and fewer legal points of entry between the two countries. Considering this, the Kosi Bay and Farazela port of entry is the only legal port of entry along the southern border between the two countries (Kruys, 2002).

The southern Mozambican and South African borders were reopened in 1994 after the two countries had held democratic elections. The reopening of the border signalled a new era of cooperation between the two countries. The electrified fence on the eastern part of the South African and Mozambican border, which is situated between the Kruger National Park and eSwatini, was switched from lethal to detect mode, which

became a symbol of the relaxation of international relations between the two countries (Kruys, 2002).

The presence of illegal activities along the South African and Mozambican border is not a new phenomenon. Earlier studies by authors, such as Kloppers (2005), have found that the fence separating the two countries has been cut at regular intervals to facilitate illegal cross-border activities. Hennop, Jefferson and McLean (2001) also found that there were at least 67 illegal crossing points, which were mainly used by traffickers as an alternative to established border posts. The locality of communities close to the international borders also contributes to illegal border crossings. Local communities on both sides of the countries embark on cross-border journeys on a daily, weekly, or monthly basis to visit friends and families or to purchase food and other commodities in one of the two countries (Kloppers, 2005).

The Mbangweni border, which is situated between the Ndumo Game Reserve and the Tembe Elephant Park, has historically been a source of illegal activities, including the smuggling of illegal migrants, drugs and weapons. The area is situated 50 kilometres from an official border post –only if it was possible to travel directly from Mbangweni to the border post. Even if a person were to enter Mozambique through a formal border post, it would require one to take a long detour by travelling to Shobane, which would take about six hours. This explains why residents residing in proximity to the international border prefer to cross at an unofficial crossing point, rather than at a legal border post, which is situated far from their homes. In addition to visiting friend and families, local communities on the South African side of the international border cross into Mozambique to fetch water, to fish in Rio Maputo, and to engage in agricultural activities (Kloppers, 2005).

The border at KwaMshudu differs from Mbangweni. It is located closer to Manguzi where there is regular transportation from Manguzi to the Mozambican border. This makes it an attractive option for many Mozambicans who want to visit South Africa. However, the border is not without its challenges. Like the Mbangweni border area, it also experiences criminal activities such as illegal migration, and the smuggling of stolen vehicles and contraband (Kloppers, 2005). Moreover, criminal elements use places in the far northern areas of KwaZulu-Natal and the Mozambique border, such

as Gate Six, Muzi, the Nduno Nature Reserve, and the Kosi Bay area to smuggle illegal firearms, goods and migrants. The destinations for illegal goods and immigrants entering South Africa are normally Durban or Johannesburg (Hennop et al., 2001).

In addition, the Lebombo border post, in Komatipoort in the Mpumalanga province of South Africa, and the corresponding Mozambican border post, Ressano Garcia, situated in the southwest of Mozambique, serve as the main and busiest commercial border post between South Africa and Mozambique. This border area is historically characterised by cross-border crimes such as illegal migration and human trafficking. Several small-scale trafficking networks also operate within the Lebombo-Komatipoort area, where migrants and women are trafficked through the border post, in collusion with border officials, and through the porous borderline by criminal elements and accomplices operating as far away as Johannesburg in South Africa (Martens, Pieczkowiski & Van Vuuren-Smyth, 2003; Martin, 2018; Molosongololo, 2000; UNESCO, 2007).

2.4.2.3 South Africa-Botswana borders

The South Africa-Botswana border is South Africa's longest international land border, and it covers some 1900 kilometres. The border area is situated mainly in remote and sparsely populated terrain in South Africa's provinces of the Northern Cape, the North-West, and Limpopo. The area consists of harsh dry terrain, with large open plains, surrounded by mountains (DHA, 2017). South Africa and Botswana share 17 border posts. Four are in the Northern Cape Province, eight in the North-West Province, and a further five in the Limpopo Province. At the North -West Province's border, villagers living in proximity to the border indicate that the fence is the only thing that separates them as they share the same bloodline with the people on the other side of the fence. Many of the villages in the border area bear similar names, such as Mabule, Tshidilamolomo, and Makgori. Other border gates are situated at Makgobistad, Kopfontein and Tlokwe on the Botswana side, which are the major border posts between the two countries. The Kopfontein border post is situated 60 kilometres from the town of Zeerust in the North-West Province and is one of the main and busiest border posts on the South Africa-Botswana border. Another busy border post in the

Ramatlabama border post, situated 25 kilometres north of Mafikeng in South Africa. The Northern Cape part of the border consists of a remote, sparsely populated and harsh dry terrain characterised by large open plains, surrounded by mountains (Hennop et al., 2001; Tau & Ramatlhatse, 2012; DHA, 2017; Tau, 2019).

In the Limpopo Province, there are four border posts between South Africa and Botswana. The border posts are the Zanzibar border post, which is situated 190 kilometres from Lephalale; the Platjan border post, located between Alldays and Selebi Pikwa; the Pontdrift border post, located about 110 kilometres from Musina; and the Groblersbrug border post near Tom Burke in the Waterberg District. In most parts of the border area between South Africa and Botswana the fence, which supposedly safeguards the border between the two countries, is a short agricultural barrier, which can be bypassed easily and does not serve as a significant deterrent. In some areas, the fence is non-existent, or criminals have resorted to cutting holes into the fence with pliers so that stolen vehicles and cattle, and counterfeit goods can be smuggled across the border. Furthermore, the roads along the border are mostly inaccessible; this makes it difficult for border authorities to conduct patrols (Politicsweb, 2019).

2.4.2.4 South Africa-eSwatini borders

eSwatini shares its international borders with two countries, namely South Africa and Mozambique. The total number of border posts between South Africa and eSwatini is eleven. Nine of these border posts are situated in the Mpumalanga Province of South Africa and two in the KwaZulu-Natal Province. Challenges experienced in the border area are the absence of, or damaged, border fences, and illegal crossing spots along the border. Some of the affected areas are the areas between Pongola and Piet Retief. In other areas, the international border is marked by painted stones (Hennop et al., 2001; Magubane, 2018; Simelane, 2016). Much like the challenges experienced on the South Africa-Mozambique border and the South Africa-Botswana border, residents of the Magogeni border area near the Mananga border post do not seem to be bothered by illegal border crossings and regard such activities as normal. Also, the road along the international border fence is not well maintained and it is unsuitable for border authorities to conduct patrols. In addition, the forests in other areas are dense; this

situation is exacerbated by forestry companies that own forests that run across both sides of the border (SA News, 2009). The South Africa-Swaziland border is also not immune to transnational crimes, and it experiences illegal activities, for example, the illegal crossing of persons (including schoolchildren), dagga smuggling, cattle rustling, the smuggling of goods, and illegal mining activities (Martin, 2018).

2.4.2.5 South Africa-Namibia borders

The border area between Namibia and South Africa stretches over 960 kilometres from the West Coast of South Africa all the way up through the Kalahari Desert. The borderland between these two countries is demarcated by the Orange River. The remainder of the borderland is marked by a fence, which serves only as a marker and is just above a meter high in some places. There are seven border posts separating South Africa and Namibia, and all of them are situated in the Northern Cape Province of South Africa (Hennop et al., 2001). The busiest border post in this region is the Nakop border post, which is situated 31 kilometres from the Namibian border post and 15 kilometres from the borderline separating the two countries. The terrain in this border area is characterised by a range of small mountains, pans, and semi-desert plains, which makes it difficult for border law enforcement authorities to conduct foot and vehicle patrols in the area (Hennop et al., 2001).

Another border post in the South Africa-Namibia border area is the Vioolsdrift border post. The borderland in that area stretches for 80 kilometres on each side of the border post on the Orange River (Hennop et al., 2001). The Vioolsdrift border post is situated in the Namibian village of Noordoewer, and the village of Vioolsdrift in the Namaqualand area of the Northern Cape Province in South Africa. The Alexander Bay border post, which follows the Orange River from the Atlantic Ocean for some 140 kilometres, is another border post between South Africa and Namibia. It consists of 400 kilometres of borderland, stretching from the Orange River mouth up to the Groen River. Like other border areas on the South Africa-Namibia border, the mountainous terrain makes it difficult for border law enforcement authorities to patrol the area due to the mountains, which force the road away from the river. Accordingly, it is almost

impossible to monitor and control the border area and the river without specialised equipment and methods (Hennop et al., 2001).

2.4.2.6 South Africa-Zimbabwe borders

The border between South Africa and Zimbabwe is approximately 200 kilometres long, and it runs along a section of the Limpopo River. The Limpopo River serves as a principal deterrent to illegal border crossings. The three-lined barbed wire fence on the South African side of the border complements the natural Limpopo River barrier. Apart from the borderline as a non-human factor of border security, the Beit Bridge border post is the only border post linking South Africa and Zimbabwe, and it is strategically located for both continental travel and trade. It was built between 1924 and 1992 because of a gradual increase in movement between the two countries (Trollip, 2013; Tshabalala, 2017).

The name Beit Bridge not only refers to the name of the border post, but it also refers to the town on the Zimbabwe bank of the Limpopo River. Moreover, it is the busiest land border post in South Africa and connects the country by land to the entire continent. It also connects the entire continent to almost the entire South Africa through the N1 Highway. On the South African side, the Beit Bridge border post is in the Musina Local Municipality in the Limpopo Province; it is situated in a spectacular landscape of hills and baobab trees. Musina is unique in the sense that it directly hosts two international borders; that is, Botswana to the north-west and Zimbabwe to the north. It is also near the Kruger National Park, which shares a border with Mozambique to the east (Trollip, 2013; Tshabalala, 2017).

This discussion above suggests that there are similarities in terms of the border landscape across all the borders with all South Africa's neighbouring countries. The discussion also indicates that there are similarities in terms of the border challenges experienced in most of the border areas with neighbouring countries. These factors will be discussed in detail later in this chapter.

2.5 Border security management in South Africa

The South African border environment and its management is characterised by several challenges. Most of these challenges are not new but have a historical origin. Key to the challenges are the vastness and porousness of the borders; poor coordination and lack of synergy by border authorities; inadequate human and physical resources to aid border agencies; and budgetary constraints faced by state entities employed in the border security environment.

With states being duty-bound to protect their sovereignty, independence and citizens from adversaries and criminal elements, organs of state are guided by the applicable legal instruments, which must be in place to enable states to achieve such important national security objectives. Moreover, there should be adequate resources and technology to aid these organs of state to achieve the said objectives.

This section of the study will examine the historical development of border control work in South Africa and the current institutional and legal frameworks applicable to border security in the country. This approach will allow the researcher to identify historical challenges and issues of border control and security in South Africa and to lay a platform for a detailed discussion of the current nature and challenges of border security in the country.

2.5.1 Historical overview of border security management in South Africa

A country at peace with its neighbours normally assigns Home Affairs to control the movement of people across borders in support of its human capital and developmental needs, as opposed to the military or the police whose role would be more restrictive and aimed at defending a country from aggressors. It will also assign Customs and Excise the mandate of facilitating the movement of goods, while also facilitating trade and enforcing national tariff and trade tax regimes. This was not the case in apartheid South Africa because of the hostilities experienced with its neighbouring countries. As such, the approach to border security management was highly militarised with the main intention of neutralising liberation movements who were dedicated to infiltrate South

Africa to fight the system of oppression. Key state departments in this regard were the then South African Defence Force (SADF) and the partially militarised South African Police (SAP) (Hennop et al., 2001; Steinberg, 2005).

Steinberg (2005) asserts that due to global restrictions in trade imposed by the international community, South Africa had to resort to illicit international trade, and the involvement of state intelligence structures in the border security environment was permanent and powerful. During this period, South Africa's international land borders were reinforced with lethal electric fences and regular patrols by army personnel and commando units. These measures were also intended to deter and prevent infiltration by liberation movements. These measures were supplemented by internal military and police clampdowns and raids across South Africa's international borders to what were termed frontline states, including Namibia, Angola, Mozambique, and Zimbabwe. All these countries supported and hosted South Africa's liberation movements during the apartheid period (McMichael, 2012).

With the transition to democracy in 1994, the Interim Constitution assigned the SAPS as a lead department regarding the movement of people and goods across South Africa's international borders. This was contrary to norms in countries at peace with their neighbours and that were in pursuance of democratic market economies. One example being the United Kingdom where the leading role in border management was usually assigned to the immigration section of the Department of Home Affairs or Customs and Excise at commercial ports of entry. The rationale behind this type of arrangement is that the immigration and custom and excise functions are key activities at ports of entry, and the role of the police is normally supportive in nature and involves the prevention, detection, and investigation of crimes (Hennop et al., 2001; Steinberg, 2005).

To comply with international norms and to adjust to the changes in the South African risk profile, there was an urgent need for South Africa to relook its approach to border security management following the transition to democracy in 1994. As a result, South Africa has seen several paradigms shifts on border security since its attainment of democracy in 1994. Both intuitional arrangements and legal frameworks for border security and control have seen several changes since then. To make the necessary

recommendations and effect the necessary changes in border security and control approaches, various entities undertook an assessment of the then border management approaches in South Africa, and several findings were made, accompanied by the necessary recommendations. Some of the findings related to the high number of airports; a fragmented approach to border security; the militarisation of border control and safeguarding; poorly designed ports and border posts; understaffed border posts; and poor recruitment and training practices of border officials. Some of the challenges experienced then remain relevant in the current border security management setting (Erasmus, 2020; Hennop et al., 2001; Steinberg, 2005).

Given the above, one of the immediate changes implemented by the South African government was the establishment of the Border Police function by the SAPS in 1995 to look at border policing at land border posts, harbours, and airports. Yet, the daily command and control of the border policing function was decentralised to provincial policing structures. At the same time, the DHA also started to position itself for a lead role in managing the movement of persons across the South African borders. There was also a merger of revenue services with Customs and Excise in 1996 in what was termed a large-scale institutional convergence project. In 2004, the command and control of South Africa's border function was centralised to the Division Protection and Security Services at national level. This was reversed in 2010 where the Border Police function was returned to provincial policing structures. A further re-organisation of the border police function occurred in 2016 when the command and control of all border policing activities was centralised under the Division Operational Response Services (Esterhuyse, 2019; Klaaren & Ramji, 2001; Minnaar, 2001; Steinberg, 2005).

Other developments in the border security management environment in South Africa included the establishment of the National Interdepartmental Structure (NIDS) which occurred in 1997 through the National Crime Prevention Strategy launched in 1996. The purpose of the NIDS was to provide guidance to the various entities involved in border control and to develop a philosophy of border control in South Africa. All key government institutions involved in border control were represented in this structure in a five-year project, which ran up to 2001.This structure was successful in rectifying some of the border environment challenges, such as the reduction of international airports from 32 to ten; the redesign of ports and border posts; and the establishment

of process flows at ports of entry. The establishment of NIDS was not without controversy and challenges as it functioned in a disjointed way and each of the state departments involved in the structure protected their own interests and independence at the expense of other institutions (Cilliers 2000; Minnaar, 2010; Politicsweb, 2020; Steinberg, 2005).

After NIDS, the Border Control Operational Coordinating Committee (BCOCC) was established in 2001, which was chaired by the head of Border Police. During this period, the BCOCC also had its fair share of challenges; for example: unclear reporting channels; poor decision-making processes; and self-serving interests by key departments to an extent than less resourced departments in the border control environment were as a result, side-lined in border management and control. Further to that, in the year 2004, a decision was taken to reassign the lead role from the SAPS to the DHA. The DHA became a lead agency at non-commercial ports of entry while the SARS took leadership at commercial ports of entry (BMA, 2015; Mahlangu, 2016).

In the year 2007, it was further announced that Cabinet has decided to allocate the task of coordinating South African border control work to the SARS in line with international norms and standards. The BCOCC was responsible for both the strategic and operational management and control of the South African border environment through coordination. Its tasks included implementing and shaping aspects of border management legislation; policy; and to improve legal flow. It was further responsible for promoting trade, tourism, and development; and coordinating issues of law enforcement and security at ports of entry. It also had an administrative responsibility of budget management and maintenance of ports of entry. Thus, the Ministry of Finance and SARS became responsible for the overall coordination of the BCOCC structures at ports of entry, and the SARS was further empowered by Cabinet to be the lead agency in facilitating and coordinating cross-functional programmes and projects of the BCOCC. A further structure for the coordination of border control work was established in 2010 through the Inter-Agency Clearing Forum (IACF) in view of the 2010 Soccer World Cup hosted by South Africa. This structure was chaired by the Director-General of Home Affairs. In 2014, the South African Cabinet took a resolution that responsibilities assigned to the BCOCC should be transferred from the SARS to the DHA. This was amid its failure to deliver on its mandate of addressing

challenges of border control work (Mahlangu, 2016; Politicsweb, 2020; Steinberg, 2005; Taute, 2007).

The level of security at South Africa's international borders and ports of entry, has not been very effective in curbing the illegal flow of persons and counterfeit goods into and out of South Africa. It is for this reason that the establishment of a single and legislatively mandated border security management structure has been considered as one of the best alternatives to improve the security and integrity of the country's ports of entry and international borders. This will be achieved through the formation of a single, more integrated, and secure border security and management process, and through the development of a well-formulated strategy of national border safeguarding (Baker, 2009; Politicsweb, 2020).

Currently, the establishment of the Border Management Authority (BMA) is still under consideration and yet to be finalised. The establishment of the BMA was announced in 2009 by the then president of South Africa, Jacob Zuma. However, interim measures of coordinating border control work have been put in place, with the DHA as the lead agency at border posts through the BMA Project Management Office and guided by the Integrated Border Management Strategy (IBMS). Despite this, the SANDF remains responsible for safeguarding the borderline (Baker, 2009; Mahlangu & Obioha, 2015; Politicsweb, 2020).

The aim of the BMA is to consolidate the entire border environment under the DHA, including the border safeguarding function, by addressing the historical challenges of corruption, the poor training standards of officials and the shortage of staff; the lack of or poor infrastructure and technology; and to further improve coordination among departments within the border control environment. The continuous restructuring of the border control work has undoubtedly created much uncertainty and resulted in a lack of policy direction over the years, especially at an operational level. Further, it can be argued that the current multi-departmental approach to border security management is ineffective, both on a legal and an institutional basis (Baker, 2009; Mahlangu & Obioha, 2015; Politicsweb, 2020).

2.5.2 Legal and institutional arrangements for border security management in South Africa

Threats and risks to border security place greater responsibility on states to put in place a variety of measures to enhance national security and to further protect citizens from such threats and risks. Key role players on border security matters are usually institutions responsible for managing the movement of people and goods; intelligence gathering; policing; preventing crimes against the state; and institutions responsible for agriculture and health services. This in determined by each country's laws (Segell, 2005; Lamptey, 2010). Considering this, the function of border security in South Africa is executed by more than 18 state departments and agencies, with each of the institutions deriving its mandate from different legislative and policy frameworks. Departments involved in border security are SAPS, the SANDF, DALRRD, the DOH, the DHA, and SARS. These are the main departments involved in border security and control at South Africa's land borders (Colesky & Raath, 2015).

The State Security Agency (SSA), the Department of Tourism (DOT), the Department of Transport (DOT) and the Road Traffic Management Corporation (RTMC) are some of departments involved in the land border environment. The discussion in this study will be limited to four key departments, namely SAPS, SARS, the SANDF, and the DHA. These departments have a significant presence at land ports of entry in South Africa and have all, except for the SANDF, assumed the role of a lead department and further assumed the chair of various port control coordinating structures at South African ports of entry. The SANDF, on the other hand, has upheld its status as the key department on borderline security and control in South Africa (BMA, 2015).

2.5.2.1 South African Police Service

Members of SAPS are mandated to execute their mandate in terms of Section 199(1) of the Constitution of the Republic of South Africa, Act 108 of 1996, read together with the South African Police Service Act, Act 68 of 1995, as amended by the South African Police Service Amendment Act, Act 57 of 2008. Furthermore, the Criminal Procedure Act, Act 51 of 1977, empowers police officers to combat crime. The specific

objective of SAPS, as specified in Section 205(3) of the Constitution, is to prevent, combat and investigate crime. Besides, SAPS is tasked with maintaining public order, protecting and securing the inhabitants of South Africa and their property, and upholding and enforcing the law. Section 13(6) of the South African Police Act also empowers SAPS to conduct searches and seizures on any person, premise, place, vehicle or aircraft at any location or place within South Africa to control the illegal movement of persons and goods across the country's international borders (South Africa, 1996; South Africa, 1995; South Africa, 1997).

Border law enforcement activities assigned to the component border policing can only be discharged within ten kilometres or any reasonable distance from the country's international land borders with neighbouring countries, or within ten kilometres of the country's territorial waters or any airport. Despite the continuous restructuring of the SAPS' border policing function since the advent of democracy in South Africa in 1994, the general mandate of SAPS in the border control environment has remained the prevention, detection and investigation of cross-border criminal activities and the illegal movement of people and goods across the international borders of South Africa, which includes land borders, maritime points of entry, and airports (SAPS, 2020; South Africa, 2021).

2.5.2.2 South African National Defence Force

Considering the apartheid era history of South Africa of oppression and a highly militarised state, the post-apartheid period saw efforts by the newly formed democratic government to reduce the presence of the SANDF on the country's borders. In 2003, the government resolved that the deployment of the military at South African borders be phased out gradually and placed under the control of SAPS. It was further announced that army units deployed for border control work were to be withdrawn entirely by 2009. This decision was reversed in September 2009 when a presidential order authorised the continuation of the SANDF in border safeguarding until the end of the 2010 Soccer World Cup. Later in 2009, the Cabinet officially announced that the SANDF was once again the primary statutory agency for "borderline control and protection" (McMichael, 2012).

Like with SAPS, the Constitution of South Africa serves as the main guiding force of the SANDF. The Constitution further stipulates that South Africa has a single defence force and the SANDF is the only lawful military force in the country. In terms of Section 200(2) of the Constitution, the primary objective of the SANDF is to defend and protect the Republic of South Africa, its territorial integrity, and its people in line with the Constitution and the principles of international law regulating the use of force (RSA, 1996). Moreover, Section 18(1) of the Defence Act, Act 42 of 2002, empowers the President of South Africa or the Minister of Defence to authorise the deployment of the SANDF for the purpose of preserving life, health or property during an emergency, or during a humanitarian relief operation (South Africa, 2002a).

The SANDF could also be deployed to ensure the provision of essential services; to support state departments for any other objective including support for purposes of socio-economic upliftment; and to render effective border control work. Section 18(2)(d) of the Defence Act further mandates the SANDF to exercise border control and security. The border safeguarding task is executed as Operation Corona by the Joint Operations Division of the SANDF (RSA, 2002; Defenceweb, 2020). Against this background, Baker (2010) asserts that the capabilities of the SANDF should be directed at a specific goal, and that specific goal would entail securing South Africa by deterring, dissuading, deterring, denying, disrupting, and defeating any form of thereat.

The two fundamental tasks of the SANDF would be to secure the country's international borders and the maritime Exclusive Economic Zone (EEZ); and, being prepared and equipped to undertake military operations outside South Africa's borders. In addition, Section 19(1) of the Defence Act allows the SANDF to be deployed in support of SAPS in combating crime and maintaining law and order. However, before this can happen, Section 19(2) prescribes that a 24-hour notice should be given through the Government Gazette. Similarly, a notice should be given immediately when the SANDF's supportive role ceases. Section 20(1) of the Defence Act stipulates that a member of the SANDF has the same powers of arrest as those conferred on members of SAPS, as contained in Section 13(6) of the SAPS Act, Act 68 of 1995 (South Africa, 1995; South Africa, 2002).

Given the above, the SANDF protects South Africa's borders by performing various border security functions, which include conducting foot and mobile patrols along the land borders; establishing observation and listening posts at various points along the land borders; and operating various vehicle control points near the border area. Other border security tasks performed by the SANDF include the provision of a reaction force and participation in operations in the border area and conducting roadblocks within a defined border area in support of or in conjunction with other government departments, such as SAPS. It also collects information by undertaking intelligence collection operations (PMG, 2010).

2.5.2.3 Department of Home Affairs

Key pieces of legislation guiding the DHA in its migration management mandate are the Immigration Act, Act 13 of 2002 and the Refugee Act, Act 130 of 1998. The Immigration Act was adopted in 2002 following the tabling before the Parliament of the White Paper on International Migration (1999) and the Immigration Bill (2001). The Immigration Act became a significant policy and legislative move from the apartheid era's Aliens Control Act, Act 96 of 1991, which regulated the entry, residence and departure of foreign nationals in South Africa (South Africa, 1998; South Africa, 2002b; DHA, 2017). Considering this, Section 9 of the Immigration Act provides direction on the admission requirements and conditions that any person entering and departing from the country must adhere to.

In terms of Section 9(1) of the Immigration Act, a person is not allowed to enter or leave South Africa at any place other than a designated port of entry. Furthermore, Section 9(3) of the Immigration Act compels every person to be in possession of a valid passport for the purpose of entering or departing from South Africa. Other sections of the Immigration Act, such as Sections 11 to 23, provide for the various types of temporary residence visas that could be granted to foreign nationals, such as visitors, study, treaty agreements, business, medical treatment, and critical skills visas. Other visas provided for in terms of these sections are intra-company, corporate, retirement, exchange programmes and asylum transit visas (South Africa, 2002; DHA, 2017).

Apart from the legislative provisions discussed above, the Preamble to the Immigration Act, Act 13 of 2002, emphasises several migration management principles. They include eased requirements and procedures, and the speedy issuance of all types of residence permits; security and state control over immigration; inter-departmental cooperation and coordination; and the recognition of globalisation and other trade facilitation agreements such as the General Agreement on Trade in Services (GATS). It also emphasises aspects such as the strengthening of border monitoring and control and the deterrence of illegal migration; the efficient management and administration of ports of entry; and the efficient and effective enforcement of immigration laws. The Preamble also supports the development goal of South Africa through the attraction of scarce skills, but not at the expense of South African workers, and the maintenance of policy connection between foreigner workers and the training of citizens. It also supports compliance to international humanitarian agreements and treaties, by encouraging international collaborations in addressing migration issues of common concern; ensuring that human rights are always protected during immigration control processes; and it encourages the prevention and countering of acts of xenophobia across all spheres of government and civil society (RSA, 2002; DHA, 2017).

The Refugee Act was adopted in 1998 with its main aim being giving effect to international instruments and agreements. The specific purpose of the Refugee Act is to provide a welcoming atmosphere for the reception of asylum seekers, to set conditions for the application and determination of refugee status, and to define the rights of refugees and the conditions of residence in South Africa. The Refugee Act also outlines conditions by which persons may qualify for or be excluded from refugee status. The establishment of refugee reception offices, together with the appointment of refugee reception officers and refugee status determination officers, is also provided for in the Act. On the other hand, the Act provides for the establishment of oversight structures in the form of a Standing Committee for Refugee Affairs (SCRA) and a Refugee Appeal Board (RAB). Moreover, the Act provides specific guidance on the composition, powers, duties, and conditions of office of members of both bodies (RSA, 1998; DHA, 2017).

The Immigration Act further empowers the DHA to designate ports of entry and further handle the administrative process of the entry and departure of persons at such

designated points of entry in South Africa. In turn, the immigration services component of the DHA has the responsibility of enforcing the Immigration Act and Regulations. It is also responsible for giving effect to the Refugee Act by designating and operating refugee reception office across the country, and processing and determining the status of asylum seekers refugees. Another responsibility of the immigration services component includes the detention and deportation of illegal migrants. In summary, the DHA regulates the movement of persons into and out of South Africa's borders and their residence in the country. Moreover, the Inspectorate component of the DHA is mandated to enforce the Immigration Act (RSA, 2002; DHA, 2019).

2.5.2.4 South African Revenue Services

The movement of goods across the country's international borders are regulated and controlled by SARS through its Customs and Excise component. The Customs and Excise component derives its legal mandate from the Customs and Excise Control Act, Act 91 of 1964. Moreover, SARS derives its revenue collection mandate from the Revenue Services Act, Act 34 of 1997. This Act mandates SARS to collect all revenues due to the state and to ensure compliance with this legislation. This Act also empowers SARS to render customs and exercise services, which will ensure maximised revenue collection for the state, facilitate trade, and protect borders (Mahlangu & Ebioha, 2015; RSA, 1964; RSA, 1997).

Similar to the DHA, the Customs and Excise component of SARS is also responsible for designating certain ports of entry in South Africa for use in the importation and exportation of goods, and for discharging the administrative mandate and levying of customs and excise duties and taxes applicable to imported or exported goods (SARS, 2020). Section 15(1) of the Customs and Exercise Act places a duty on any person entering or departing South Africa to declare all goods, which are in his or her possession at the time of entry or departure, and where such goods were purchased or acquired abroad. This is also applicable to goods, which have been remodelled or repaired abroad; and goods, which are according to any other law, are restricted or required to be declared before they depart from South Africa. Against this background, more than four percent of the entire national revenue collected is through customs and

excise duties (RSA, 1997; SARS, 2020; Erasmus, 2020). As discussed earlier in this study, SARS assumed the role of a lead department in border control work in 2007. It became the lead department at all ports of entry in South Africa and further assumed the chair of the BCOCC.

Another department involved in border control work at South Africa's borders is the Department of Transport (DOT), which is responsible for the regulation of various forms of transportation in South Africa, including public transport, motor vehicles, freight, civil aviation, rail transportation, and shipping (BMA, 2015). The DOH through its Port Health Services (PHS) has the role of monitoring and evaluating all foodstuffs, disinfectants, cosmetics, hazardous substances, and medical products entering the country through the ports of entry. It is also responsible for controlling and monitoring the possible entry of all serious and contagious diseases into South Africa. Like the DHA and SARS, the International Health Regulations Act, Act No 28 of 1974, provides for the designation of any part in South Africa as an approved port of entry. Thus, the decision to designate any place in South Africa becomes a collective decision taken by the Cabinet (BMA, 2015; DHA, 2017).

Another department involved in border control work in South Africa is the Department of Agriculture Land Reform and Rural Development (DALRRD), which is responsible for the administrative control of agricultural products and fisheries at ports of entry in South Africa. It regulates the importation of plants and animal, including their products and other forms of regulated articles, which might carry pests and diseases, and other bio-security threats, which have the potential of causing harm to the South African agricultural environment and society in general (Geldenhuys, 2019; DAFF, 2020). On the other hand, the State Security Agency (SSA) is responsible for collecting, collating, and analysing information on various security threats posed by both the movement of people and goods across South Africa's international borders (Geldenhuys, 2019).

2.5.3 Regional and international cooperation

Many countries continue to face the daunting task of managing their borders in a manner that enhances national and regional security; strengthens cross-border

cooperation and regional integration; facilitates trade by removing barriers and obstacles to trade; promotes tourism; and prevents the illegal entry and departure of persons and goods. These challenges are exacerbated by globalisation, which has made it easy for people and goods to move across international borders. Another factor for consideration is the ability of criminal elements to commit transnational crimes without having to cross international borders. Cyberspace has also made it easy to facilitate not only trade between countries, but also for criminal activities to prevail with relative ease. Considering this, transnational crimes, as the word says, are international in nature, and require cooperation and mutual assistance from the entire international community, regardless of whom a country might share its borders with (Nsereko, 1997; Okumu, 2011; Van der Spuy & Tait, 2010).

Given the above, Africa, and South Africa in particular, is not immune to the challenge of managing its international borders. The increase in the movement of people and goods across countries has put strain on border management processes in Africa. All these factors require African states to devise effective border management strategies and systems that will deter, prevent, and detect transnational crimes. Moreover, it has become necessary for African states to employ systems that will enhance harmony between and among states; and increase collaborative law enforcement and information sharing efforts. It is also critical for African states to employ strategies and systems, which will enhance cross-border trade and further facilitate the legal movement of persons across borders (Cheema, 2011; Chumba, Okoth & Were, 2016; Okumu, 2011; Rozemarijn, 2013).

Regional and international cooperation in the context of border security occurs at various levels and across various border security functions. It can occur at a technical level where officials on the two sides of the border engage on operational border security and management issues. Issues for discussion in the technical cross-border forums can include the planning and execution of joint operations; activation of joint surveillance and border patrols; information sharing; and the joint management of border functions and processes. Cooperation can also occur at the inter-state level between adjoining states. Matters of interest at an inter-state level can include issues of border security and management, where policy and strategic issues are discussed and shaped. Bi-lateral cooperation is not limited to two neighbouring countries but can

be extended to include more than two countries on issues of common interest (Mahlangu, 2016).

There are several regional border management forums in the Southern African Development Community (SADC). However, the forums function in a disjointed manner; hence, they affect the effectiveness of border management in the region. Additionally, there is an absence of a comprehensive border management forum in the SADC region, which will examine every aspect of border management, as opposed to the current narrowly focused sector specific committees. Against this background, each entity operating in the border environment in South Africa may partake in a function-specific regional or international cooperation, such as SAPS in Interpol cooperation for the purpose of transnational crimes; and SARS in the SADC Customs Union or World Customs Organisation (WCO) for the movement of goods and the facilitation of trade across countries. Furthermore, cooperation between the DHA and the International Organisation for Migration (IOM) can take place on issues involving the movement of persons across international borders. There has also been regional and international cooperation to deal with other transnational crimes such as human trafficking, drug smuggling, and wildlife trafficking and trade (Mandrup, Kleynhans & Blaine, 2019).

When it comes to regional and international police cooperation, the extent of transnational crimes across the globe has resulted in the formation of several regional and international policing organisations and forums. One of the international organisations is Interpol, which was initially established in 1923, dissolved in 1938, and reintroduced in 1946. Interpol serves as an instrument for mutual assistance between police authorities of member states. It also provides the platform and tools for information sharing on matters of transnational crimes and terrorism, and for combatting transnational crimes and terrorism (Interpol, 2019). Also, SADC joined the rest of the world in the establishment of inter-regional policing cooperation to improve information sharing and cross-border policing, and to curb transnational crimes such as money-laundering, human trafficking and smuggling, terrorism, illegal migration, illicit trade, wildlife trafficking, and stock and motor vehicle theft. This is because a single act of criminality of this kind may well be committed across multiple countries at the same time and can violate the territorial integrity of each affected state. SADC established a regional police body, the Southern African Regional Police Chiefs

Cooperation Organisation (SARPCCO), in 1995 supported by the Sub-Regional Bureau of Interpol, which comprises all police chiefs in the region, to deal with crimes of mutual regional concern (Van der Spuy & Tait, 2010; Gastrow, 2013).

SAPS through its Organised Crime Investigation Unit (OCIU) also established close relationships and collaboration with police structures in neighbouring countries to curb transnational organised crimes. Another SADC cross-border crime-fighting initiative was the formation of the Protocol on Combating Illicit Drug Trafficking in 1996, which sought to reduce transnational criminal activities through collaborative efforts among law enforcement agencies in the region (Nsereko, 1997; Minnaar, 2001). South Africa is also a signatory to the United Nations Convention on Transnational Organised Crime (UNCTOC), and it is expected to render assistance to other countries on issues of transnational crimes when required to do so. It is also expected from other countries to provide the necessary assistance and information to South African, when needed. These requests, which could entail mutual assistance and cooperation on processing requests for evidence, the recovery of the proceeds of crime, and the execution of sentences, are processed through the courts (Global Action against Trafficking in Persons and the Smuggling of Migrants, 2016).

Like transnational crimes, the global migration phenomenon has become a matter of concern, which cannot be left to one country to manage, nor can be managed between two neighbouring countries. It is a matter that requires close and mutual relationships across many countries, especially at the regional level. Thus, harmonised migration policies, systems and processes become necessary for effective inter-state collaboration. Against this background, the Protocol on the Free Movement of Persons in SADC, which is aimed at removing obstacles and make it easier for SADC citizens to move across the borders of member states, is a key instrument of regional cooperation in the SADC region. It offers SADC citizens free visas of up to three months to enter any of the member states and only for lawful purposes and only when such citizens abide by the host country's laws and migration policies. The Protocol on the Free Movement of Persons was initially introduced in 1995 when a ten-year concession on the free movement of persons was targeted. It, however, received resistance from some member states when the notion of a complete abolishment of border controls was rejected by countries such as Botswana, South Africa, and

Namibia. Ultimately, the idea of the free movement protocol was dropped (DHA, 2017; SADC, 2005).

The idea of the free movement of persons re-emerged in 1997, and issues of concern raised by the parties during the earlier protocol in 1995 were rectified and the redrafted protocol was released in 2005. It was adopted by various governments and ratified by South Africa, Botswana, Mozambique, Lesotho, Zambia, and eSwatini. However, the protocol is not operational, as it falls short of the required two-third majority. Moreover, the SADC Protocol on Employment and Labour developed in 2014 was introduced to promote fair labour protection, basic rights and social protection to migrant workers and their family members. These was followed by the Regional Labour Migration Policy Framework and the SADC Labour Migration Action Plan, adopted in 2014 and 2016 respectively, to give effect to the identified police priority issues. Closely linked to the protocol on the free movement of persons is the SADC Protocol on Tourism, which is aimed at promoting the SADC region as a tourism destination. The main reason for cooperation on tourism matters is that the region possesses rich tourism potential, which, if positively promoted by removing barriers to tourism, will contribute to the economic and social development of member states (DHA, 2017; Maunganidze & Formica, 2018).

Apart from the broad SADC regional policy and institutional frameworks on the free movement of persons and goods, and combating transnational crimes, the DHA also works closely with international bodies such as the IOM Southern Africa. The IOM works together with various governments and regional bodies across the world to uphold and enhance the dignity of migrants. In addition, the IOM seeks to assist states to meet the growing challenges and demands of migration management and to facilitate better understanding of regional and global migration trends and issues. Through the development of sound migration policies, the IOM also contributes to regional and international social and economic development (IOM, 2013).

The cross-border movement of goods is an important economic and development factor, which also requires effective regional and international cooperation. Against this background, the SADC Protocol on Trade was developed in 1996 with the objectives of creating and facilitating free trade in the SADC region and promoting

trade between member states. The promotion of trade within the SADC region is essential to effective economic integration in the region and, as such, requires greater cooperation among member states (DHA, 2017).

Another transnational border security management aspect is the issue of cross-border cooperation around fisheries, which is one of the key initiatives and advantages of deterring and minimising illegal fishing. This is necessitated by the fact that there is a need to harvest criminal law and procedures relevant to the fisheries environment. Thus, enhanced cooperation across borders on issues of information and intelligence sharing and analysis becomes critical in identifying and pursuing organised criminal elements involved in illegal fishing activities (Isaacs & Witbooi, 2019).

2.5.4 Border and rural safety community forums

Border security and the management of migration in South Africa require an approach, which will not only be limited to cooperation among governments and state entities but should also foster interaction and cooperation with civil society in line with international best practices and achieve a common objective on security and development. There is often limited consensus on the goals and importance of global migration in South Africa, to the extent that the government and civil society are often required to decide on migration policy issues in courts – with unintended consequences (DHA, 2017; Wiese, 2019). Similar sentiments are held by Mahlangu and Obioha (2015) when they state that efficient and effective border security can only be enhanced through the participation of border communities. They further recommend the establishment of Border-Community Security Forums (BCSF) in border areas.

Buys, as quoted by Dean (2020) on the question of border safeguarding and coordination, also holds the strong view that greater cooperation and coordination is necessary between various government departments, farmers and community safety forums to combat cross-border crime through initiatives, such as the rural safety strategy. Thus, border communities are an important part of the broader border security strategy. Firstly, they are directly affected by cross-border crimes as victims, such as

in stock theft. Moreover, they are the ears and eyes of the police as they often witness cross-border crimes, and they might be a great source of intelligence (Lamptey, 2010).

In support of the above, Pule (2013) and Chelin (2019) hold the view that the establishment of forums such as the National Stock Theft Forum and the Stock Theft Information Centre (STIC) to build and sustain cooperation between the police and the farming community becomes critical in combating cross-border crimes, especially livestock theft. The farming community could be of great assistance to the police by becoming more actively involved in investigations and prevention measures. Thus, addressing transnational livestock theft requires the cooperation and collaboration between all the relevant stakeholders including local communities, farmers, civil society, and law enforcement agencies.

2.6 Nature and challenges of border security in South Africa

Managing South Africa's international borders has proven to be a daunting task. With over 4700 kilometres of international land borders and 2800 kilometres of coastal line, 72 ports of entry in both the land, maritime and aviation environments, coupled with the lack of basic and consistent governance structures, it has been difficult for South Africa's border authorities to ensure effective border security management. As a result, acts of criminality such as illegal migration and the smuggling of contraband goods and cigarettes have grown at an alarming rate. Corruption among border officials and the inefficiencies of border processes exacerbate the situation. The non-existence of a border fence in some areas and its porousness along the border area also contribute to several cross-border irregularities, namely illegal grazing and non-compliance to sanitary standards, as livestock and wildlife roam freely across international borders, and poachers and smugglers operate with relative ease. Other criminal activities include illegal migration, the smuggling of stolen vehicles, and human trafficking (Erasmus, 2020; Wiese, 2019).

Given the above, studies by Mahlangu and Obioha (2015) and Mahlangu (2016), which sought to explore the effectiveness of SAPS and other government agencies in executing border security activities, revealed several challenges related to the

implementation of effective border security in South Africa. Those challenges include issues such as administrative challenges; policy and strategy issues; and human resources constraints. Moreover, the lack of, or inadequate, training, physical resources constraints; poor organisational ethics; poorly modelled boundaries; and political and socio-economic issues on the African continent, and particularly in neighbouring countries, were identified as key challenges associated with border security in South Africa.

Most, if not all the current challenges of border security in the South African context, have existed for several years. Studies by Hennop et al. (2001), Steinberg (2005) and Minnaar (2001), which sought to explore a multitude of border security and control factors in South Africa, identified a fragmented border security governance structure; lack of resources for border control work; corruption among border officials; poorly modelled borders and the porous borderline; political and economic instability in neighbouring countries and in most parts of the African continent; and the lack of a clear policy direction as factors affecting border security management. Thus, the nature and challenges of border security and control in the South African context can be listed as legal and institutional framework challenges, and poor environmental, socio-economic, and political conditions in Africa, and particularly in neighbouring countries. This does not suggest that border security issues, such as illegal migration and other cross-border criminal activities, are only perpetuated by African migrants. In addition, poorly modelled and porous borders, corruption, capacity constraints and ineffective methods of border monitoring are challenges of border security in South Africa.

2.6.1 Legal and institutional framework challenges

Hennop et al. (2001) in their study to establish how effective border control mechanisms were in curbing the illegal movement of firearms across South Africa's international borders found that despite structures being in place to simplify co-operation among the various government departments involved in border control, a lack of proper and effective communication at all levels was prevalent in the South African border environment. The study also found that there was no communication

between the agencies, which resulted in the loss of valuable information on crime in general and the operation of criminal syndicates. Moreover, existing border control structures were ineffective in coordinating the activities of the different departments in the border environment.

The study by Steinberg (2005) aimed to provide an overview of border control structures and resources in a post-apartheid South Africa; to assess the progress made at the time of the study; to examine what had been done with the structures and resources; and to explore alternatives for the future. The study found that despite the formation of various structures of border management and control, such as the lead agency model, and inter-departmental coordination, problems of disjointed border security management remained.

Steinberg (2005) also found that individual government departments involved in border control in South Africa sought to protect their individual departmental interests at the expense of the common interests of a collective border control setting. Consequently, this affected the formulation and execution of comprehensive strategic border control targets. The proposal of the establishment of a single agency or a ministry for border control was explored as a persuasive solution, which would allow for the integration of all border security and control functions; the creation of a single identity across all the border functions; and the ability to integrate a variety of information gathering and sharing systems. However, it was not without foreseeable challenges. One such challenge was identified as the government capacity and fiscal muscle to integrate all the border functions into a single structure, and the ability to design and device the necessary systems of technology to support integration.

A study by Minnaar (2010) also found that the full integration of all border security processes was lacking in the South African context. All stakeholders agreed that there was a need for a better and a more coordinated approach to border control. The study further found that a collective approach, as in NIDS, would only suffice as a temporary solution, but a more institutionalised system of border control (through the establishment of a single and multi-functional border control agency) would be best suited to address the challenges of border control in South Africa. In support, Mahlangu and Obioha (2015) and Mahlangu (2016) in their studies, which assessed the

effectiveness and challenges of SAPS and other security agencies on land border security and control in South Africa, found that there was a lack of effective coordination and cooperation. This led to the ineffectiveness of the multi-agency approach to border control in South Africa.

The studies by Mahlangu and Obioha (2015) and Mahlangu (2016) further found that the issue of joint supervision and tasking within the border environment was problematic in the sense that border officials were not keen to be supervised or to be given operational tasks by managers from other stakeholder departments. This was attributed to varying organisational cultures and loyalty to their respective departments and direct managers. Participation in joint border management structures was mostly voluntary, lacked the necessary regulatory framework, and was mainly dependent on the state of stakeholder relations in the border area. Against this background, the study highlighted the importance of coordination and cooperation at all levels of border control, namely departmental, inter-departmental and international. Also, Taute (2007) opines that the culture of departmentalism and operating in silos for the attainment and preservation of narrow individual departmental self-interests has a detrimental effect on the much-needed coherence required to implement cross-cutting programmes, and it ultimately compromises the success of such programmes.

Similar findings and recommendations were made by Dithebe and Mukhuba (2018) in their study that explored the causes of illegal migration and weak border control in Africa and South Africa, in particular. The study found that measures undertaken by the South African government were inadequate to minimise the increase in illegal migration into the country. The authors suggested that for the South African government to improve its efforts of enhancing border security, systems of border management and control that would ensure legal entry into and departure out of the country, and a strategic plan that would foster a culture of inter- and intra-departmental and stakeholder cooperation were essential.

As stated by Mahlangu and Obioha (2015) and Mahlangu (2016), even though the current legal and institutional setting on border security management makes provision for equal participation by all state departments, it lacks a clear position on the mechanism necessary to support an effective lead-agency and border coordination and

cooperation approach. There is no clarity on the extent to which each department or agency should be involved in border security matters. This aspect is supported by empirical evidence from police officials stationed at three border posts, namely Mananga, Ficksburg and Ramatlabama. Asked which department should be responsible for border control and security, most participants supported a multi-agency approach to border security, and further supported SAPS to be the lead agency on border security and control. Improved coordination and cooperation among departments at the three land borders is key to the effectiveness of border security and control; this will further support proper management of the borders.

To date, the establishment of the BMA has not materialised mainly because of the lack of, or insufficient, cooperation among government departments and agencies operating in the border environment in South Africa. It was envisaged because of the need to establish an entity with a clear mandate of managing the diverse requirements of border control work (Dodds, 2015). This has been noted through a series of reorganisation of governance structures and processes in the border security management environment since the advent of democracy in 1994. SAPS, SARS and the DHA, as the main stakeholders in border control work, each had an opportunity to assume the role of a lead department and the chairing of coordinating structures at South African border posts. Despite numerous changes in governance structures and in leadership roles, each department retained its own discretionary powers and independent line functions. Thus, each department saw itself as an equal member in a partnership of government departments (DHA, 2017).

The rationale for the establishment of the BMA was to create an operational balance between security, trade facilitation, tourism promotion and socio-economic development within South Africa and the SADC region. It would provide for integrated border control, with officials who have a common identity under a single command structure. The agency would be equipped with the necessary skills and knowledge in law enforcement, and the core functions of the current departments, to ensure the efficient and humane delivery of secure services in an integrated manner, finally dispensing with the silo mentality prevailing at ports of entry. The establishment of a risk-targeting centre is an important aspect of the BMA, where all departmental

systems would be jointly used to assess the risk levels of conveyances, persons, and goods (DHA, 2017).

2.6.2 Poor economic, socio-cultural, and political conditions in the sub-Saharan region

Available literature suggests that the need for both legal and illegal migration commonly occurs because of several factors, which have been registered as the push factors of fewer opportunities in the socio-economic situation in a particular country or area, and also because of pull factors that exist in better developed countries or areas (Thet, 2014). Thus, push factors could be considered as factors that induce people to move out of their current location, whereas pull factors could be considered as factors that induce people to move to a new destination. Both push and pull factors must exist for migration to occur. Moreover, facilitating forces must also be present, which might entail the absence of legal or other constraints that impede migration (Kline, 2003). Therefore, international migration could consist of the forced or voluntary movement of people from countries within the same region or from other regions to seek better opportunities and conditions in the country or area of destination (Koch, 2013; Dassah, 2017; Hayes & Vermeulen, 2012).

Factors that compel migrants to migrate from one country to the other could vary from one migrant to the other. However, many migrants across the world cross their national borders daily mainly to seek better economic and social opportunities in other countries or regions. In other instances, they move within borders or across borders for work or study purposes, or for the purpose of visiting or reuniting with families. Many other migrants are forced to leave their places of residence and countries for other persuasive reasons, such as fleeing from conflicts and crises in their countries, fear of persecution, and disasters. In summary, factors influencing both legal and illegal migration can be classified into different categories. These factors are economic, environmental, demographic, socio-cultural, political, legal, historical, and educational (Castelli, 2018; Jubilut, 2017; Simpson, 2017).

It is understood that the political and economic crisis in the Southern African region has been the main driver of illegal migration into South Africa. The continental and international recognition of South Africa after the 1994 democratic elections, which shaped a new South African foreign policy, also encouraged many foreign nationals to enter the country, including an alarming growth in illegal migration. Thus, as opposed to the system of apartheid, which sealed off the country from the rest of the world, post-apartheid South Africa was built on a culture of inclusiveness, tolerance and human rights, as enshrined in the 1996 Constitution (Adjai & Lazaridis, 2013; Hart, 1996; Maharaj, 2002). Considering all these arguments, this study will focus mainly on the economic, socio-cultural, and political factors in the sub-Saharan region.

2.6.3 Economic factors

Many studies suggest that most people migrate to other countries or areas for economic reasons. It is common that most people will think of relocating from places that have fewer job opportunities to places that offer greater opportunities for employment and other economic activities. Due to global economic changes and restructuring, employment prospects will often vary from one country to another and, in some instances, within regions of the same country. In most developing countries, aspects such as low employment opportunities and lower incomes in the agricultural sector are considered basic factors that induce migrants to move to more developed areas with greater employment opportunities. Moreover, the inadequate sources of income in rural areas are also considered compelling factors for migration. Other economic push factors are low productivity levels, underdevelopment, inadequate opportunities for advancement, and depleted natural resources. Conversely, pull factors that tend to attract migrants to other countries or areas are opportunities for better employment, higher wages, better working conditions, and better and attractive facilities (Levy, Walter & Wadycki, 1973).

Apart from these historical factors, which remain relevant today, South Africa continues to be an attractive destination for both legal and illegal immigrants, persons seeking asylum, or refugees who come from politically unstable and economically challenged countries such as Lesotho, Mozambique, Zambia and eSwatini. Although

not necessarily all illegal, other migrants from countries such as the Democratic Republic of Congo (DRC), Ghana, Nigeria and other African countries flocked into South Africa for a variety of reasons, including better economic opportunities. The problem of illegal migration is not limited to African migrants, migrants from outside the African continent, such as China, India, Pakistan, and Bangladeshi, have migrated to South Africa for a variety of reasons. Some migrants have migrated to South Africa to pursue transnational criminal activities, such as diamond smuggling, dealing in illicit goods, illegal car dealings, and human smuggling (Dithebe & Mukhuba, 2018; Hart, 1996; Heleta, 2018).

2.6.4 Socio-economic and political factors

Socio-cultural factors are some of the compelling push factors of global migration that force people to migrate from their country of origin to another country, as opposed to the historical factors of international forced migration such as conflict and slavery. Large groups of people are now forced to migrate because of political instability caused by cultural differences and intolerance. In other instances, family conflicts and the quest for independence and education are causes of migration. Moreover, social factors such as improved communication and transportation networks and urban-oriented education are contributors of migration. Religious intolerance, intolerance towards certain cultural groups, and active religious intolerance are other push factors influencing the decision to migrate. On the other hand, religious tolerance in countries targeted by migrants serves as a pull factor for migration (Kainth, 2010; King, 2012; Thet, 2012). Against this background, Piesse (2014) ascribes the decision to migrate to the politicisation of religious and ethnic identities, which has the potential to cause conflict within states. Similarly, Yaro (2008) states that in traditional rural areas, traditional norms and practices and tribal conflict push people to migrate to other areas.

On the other hand, political factors such as state persecution, the lack of political liberties, and political instability play a key role in encouraging or discouraging migration from one region to another. State persecution constitutes acts of harassment, and the discrimination and torture of people who either disagree with their government or have minority religious beliefs or ethnic backgrounds. Due to unsafe conditions,

these people are forced to flee to safer countries. Thus, asylum seeking is a direct result of political migrants who flee from an oppressive state to a more democratic state. Moreover, the absence of political liberties and rights and the high levels of corruption in a country induce migrants to seek greater freedoms in other countries that offer better conditions. Poor political conditions in a country limit people's freedoms and career prospects and force them to seek better freedoms, and career and economic opportunities elsewhere. Political instability caused by cultural diversities, such as ethnic wars or religious intolerances, cause people to relocate to other areas within the same country or to other countries (Mathews, 2018; Moore & Shellman, 2004; Piesse, 2014).

Wars and armed conflicts also contribute to forced migration. There has been a rise in armed conflicts in the past half-decade, with clashes becoming more deadly. The civilian population has also been targeted with impunity by parties engaged in conflict and war (Guehenno, 2016). According to Nordland (2015), there are more displaced people and refugees now than at any other time in recorded history. Largescale displaced people include migrants from Syria, Somalia, Afghanistan, Mali, Gambia, and Eretria. These countries have experienced high and prolonged conflicts, which have increased the levels of poverty and food insecurity in the countries. It is estimated that by 2015, wars in Afghanistan, Somalia and Syria alone would have contributed to more than half of the world's refugee population (Guehenno, 2016).

Conflict-induced migration further drives other social issues such as conflict, violence, fear, environmental degradation, deprivation, identity politics and economic insecurity in host countries (Coniglio & Pesece, 2015; Hayes, Lundy & Hallward, 2016). Raleigh (2010) and Reuveny (2008) state that the relationship between conflict and migration could be a reverse one. According to these authors, factors that usually lead to population movements, such as environmental degradation and resources scarcity, could contribute to further conflict.

Furthermore, an increase in the number of migrants in migrant receiving areas or countries could cause ethnic and socio-economic tension, burden infrastructure and services, and result in competition over natural and economic resources. Similar sentiments are held by Guehenno (2016), who says that countries hosting

disproportionately large numbers of refugees without adequate support are likely to be destabilised, which could aggravate existing economic, political and security challenges. The author (2016) further suggests that the chaos in the Middle East has the potential to generate additional terrorism and refugees, while the sub-Saharan African region has the potential to become a major source of conflict and transnational terrorism.

2.6.5 Poorly modelled and porous borders

African borders are not linked to the idea of a nation-state where the philosophy of 'states make war' and 'wars make states' is key. Moreover, most of the borders in Africa are regarded as soft and political, and they do not comply with economic, geographical, and socio-cultural borders. They serve a different purpose, as opposed to borders in Western countries and other countries of the world where borders serve the purpose of generating income for states and individuals (Esterhuyse, 2019). Ikome (2012) posits that Africa's borders are porous due to a lack of proper and clear demarcations and delimitations. Nsereko (1997) points out that most SADC countries have a common social and cultural affinity and common historical experiences of colonisation; the current borders in Africa are a humiliating legacy of colonialism.

The partitioning of the African continent through the Berlin Conference (1884-1885) created many colonial boundaries, which still are in existence in Africa (Esterhuyse, 2019). The industrial nations of Europe competed with one another for the struggle for colonies on the African continent and, within a few years, were able to extend their colonial control over many parts of the world in what was termed 'the new imperialism'. Major European powers, which formed part of the Conference, were France, Britain, Belgium, Portugal and Germany. The Conference emerged as a way of stopping the scramble to degenerate into war (Afigbo, 1990).

Considering the above, Allot (1969) states that since the Berlin Conference there has never been peace in Africa. This created confusion at independence on whether to keep or do away with these colonial boundaries. Ikome (2012) suggests that the lack of proper and clear boundaries has been the main reason why governance-related state

conflict in individual states were able to spread to the whole region with relative ease, such as in West Africa, the Great Lakes region, and the Horn of Africa. Esterhuyse (2019) states that many intra-state conflicts on the African continent were sparked by the imposed merger of incompatible societies into one state and the imposition of artificial boundaries by colonial powers. These artificial borders are also blamed for the current disunity in Africa, which did not exist during pre-colonial times. On the other hand, these arbitrarily imposed borders are regarded as artificial barriers, which have separated native populations and people of the same stock. They have also created small and mutually hostile states on the African continent. These colonial boundaries broke the solid relations, which were in place, as they disregarded cultural landscapes, existing pre-colonial state systems, and political geographies. As a result, these colonial boundaries caused division among culturally homogeneous nations as they divided them into different new colonial nations to suit the vast interests of the European colonialists (Ramutsindela, 2019; Esterhuyse, 2019).

Countries such Botswana, South Africa, eSwatini (Swaziland) and Lesotho are some of the countries affected by colonial boundaries, especially regarding the separation of once homogeneous nations. For example, the Batswana people living in Botswana and those living in South Africa were once one nation under one kingship. Similarly, Sotho-speaking people living in Lesotho and in South Africa have common ancestral cultures and linguistic relations, as is the case with the SiSwati-speaking people in eSwatini and South Africa (Mahlangu & Obioha, 2015; Mahlangu, 2016). These authors further argue that these cross-border family relationships have an impact on border security and control. Similar sentiments are held by Crush (2011) who states that informal cross-border movements and illegal migration are part of South Africa's history, and they will continue due to the colonial boundaries, which have separated societies.

Participants in a study by Mahlangu and Obioha (2015) and by Mahlangu (2016) indicated that the border fences in the Lesotho, Botswana and eSwatini border areas were created where communities were already in existence and, as a result, separated those communities. The participants said that the barriers separated communities and families, and the expectation that they should cross at a designated point of entry became an issue for them. Their need to cross back and forth over the borders posed a

challenge for border control, as some people preferred to use non-designated areas to cross.

In addition to the issue of poorly modelled colonial borders, the porousness of South Africa's borders creates a challenge for border security and control. According to Crush and Williams (1999), South Africa has highly porous borders, which are beneficial to many migrants who want to avoid legal migration channels due to the fear of harassment, discrimination, and deportation. Similarly, Tati (2008) and Dithebe and Mukhuba (2018) state that South Africa's borders with its neighbours are extremely porous and they have often been blamed for the problem of illegal migration and the challenge of stabilising the number of migrants in South Africa. Moreover, border jumping presents itself as the preferred option for many migrants who want to enter the country as South Africa's migration legislation is regarded as complicated when it comes to the facilitation of migration documentation required for legal entry into the country. According to Minnaar (2001) and Delport, Koen and MacKay (2007), careless border control measures and porous borders and coastlines create the space for criminals to pursue their criminal intentions with ease. The land borders are particularly difficult for SAPS to control due to their length and because local communities share cultural relations with people in adjacent countries. The earlier discussion on the South African border environment provided an overview of the nature of the border area and the challenges related to the porousness of the borders, which are caused by the lack of or inadequate border fences on most parts of the international borderline.

As shown in **Figure 2.3**, the land border terrain in most parts of the South African border areas is either open, densely populated, or mountainous and bushy; this scenario has made it difficult for border authorities to monitor and control the border areas. For example, in most parts of the border areas of South Africa and Botswana, the border fence is a short agricultural barrier with no deterrence value. Moreover, the roads along the borderline are inaccessible making it extremely difficult, if not impossible, for authorities to conduct the necessary monitoring such as foot and vehicle patrols (Nsereko, 1997; Wiese, 2019).

In some areas of the borderline, as is the case on the South Africa-Mozambique border, the fence is non-existent, or where it exists, it is in a dilapidated state and illegal

migration and other cross-border criminal activities occur with relative ease. Moreover, the forests in other areas are dense; this situation is exacerbated by forestry companies that own forests that span both sides of the border. Similar challenges are prevalent on the South Africa-Lesotho borders and Zimbabwe (SA News, 2009; Mahlangu & Obioha, 2015; Mahlangu, 2016). On the South Africa-Lesotho borders, illegal migration and other cross-border criminal activities occur by crossing the river or walking through the bush alongside the border until they reach the border fence where they cross into South Africa. Undocumented migrants simply jump the fence or use the Caledon-Mohokare River to cross to and from Lesotho without any hindrance, especially during the dry seasons when the river's levels are low (SA News, 2009; Mahlangu & Obioha, 2015; Mahlangu, 2016; Magubane, 2018; Simelane, 2016; Wiese, 2019; Macheka, Lunga & Musarurwa, 2015).

The South Africa-Zimbabwe border presents similar challenges. To avoid detection and apprehension, many illegal migrants enter South Africa using illegal means. These include corrupting border officials and utilising risky clandestine means, such as crossing the Limpopo River and walking through the bushy area along the border, ultimately reaching the border fence where they cross into South Africa through holes in the barbed fence. Illegal migrants travel to destinations far from Musina, or they move back and forth across the border to farms located adjacent to the border between the two countries. The border also serves as a conduit for human trafficking, and for the smuggling of stolen vehicles, diamonds, wildlife, and narcotics. Vehicle smuggling occurs mostly during the dry season when the river's levels are low (Landau, 2007; Macheka et al., 2015).

Given the above, there appears to be commonalities in the characteristics and nature of the South African border landscape across all the borders with neighbouring countries. Much of South Africa's international border area spans bushy and mountainous terrain, which makes it extremely difficult for border authorities to monitor. In other areas, the international border fence is non-existent or inadequate to prevent transitional criminal activities. Moreover, the issue of illegal border crossing is not seen as problematic by communities who live close to the borders due to cross-border family ties and the interdependency of such communities.

Figure 2.3: Border terrain and infrastructure challenges

Source: Businesstech (2020a

2.6.6 Capacity constraints and less effective border security and control measures

The government departments tasked with ensuring border security in South Africa lack the necessary capacity to deal with the mammoth task of securing the country's borders and to effectively deal with cross-border crimes. Capacity refers to all key factors that are necessary to allow a state to manage issues of international migration and its borders. These could include a clear vision, a legal, policy and institutional framework, and the resources and system required to implement those policies and laws. The lack of capacity to secure South Africa's borders could be attributed to a lack of appreciation of the strategic importance of international migration and the positive role managing international migration plays in economic development and enhancing national security (DHA, 2017).

The advent of democracy in 1994 resulted in the reprioritisation of the government's programmes. Growing local law enforcement and Home Affairs budgets, and high spending on welfare programmes resulted in a reduction in the defence and border security budget. The shift in focus was due to the government's need to address critical vulnerabilities in the internal security domain and to alleviate poverty and further address inequalities (Esterhuyse, 2019). Moreover, the role of borderline security in South Africa post-1994 fell between two state departments, namely the SANDF and the under-resourced SAPS (Baker, 2009; Parliamentary Monitoring Group, 2011).

Borderline security has since been returned to the SANDF, which is also under-resourced and runs on a shoestring budget. It was anticipated that the redeployment of the SANDF to the borderline would take a while because of the need to acquire new equipment and build up intelligence and proper command and control structures once more. Moreover, the SANDF would need further funding for the restoration of border bases; the procurement of new vehicles and other equipment for the mission; and to provide mission-specific training to its troops. The Minister of Defence indicated that the SANDF had 15 companies deployed for border safeguarding, which were inadequate for the task, as it required more than 20 companies (Boshoff, 2009;

DefenceWeb, 2017; Martin, 2018). According to Daniels (2019), the SANDF is underfunded and the expenditure balance between personnel, operations and capital is misaligned and institutionally crippling.

Considering the above, Barker (2009) asserts that the task of securing South Africa's borders is a daunting one and requires a unique set of capabilities, which is not possessed by either SAPS or the SANDF. The author (2009) asserts that the task requires a set of capabilities that fall somewhere between these two entities. The task requires robust patrolling of vast and difficult terrain, which SAPS is not trained or equipped to execute. On the other hand, the border safeguarding task requires the responsible entity to enforce the law, and detain and process suspected criminals and illegal migrants, which is a task the SANDF is not capable of executing.

In support, Molemma (2017) suggest that the return of the SANDF to the borderline has had little impact on combating cross-border criminal activities, such as human trafficking. This is mainly due to limited resources to patrol the land borders and to monitor the coastline and the airspace. The author (2017) suggested that more personnel should be deployed in the areas affected by the illegal movement of persons and goods, and new technology should be employed to monitor the borders. Considering this, in 2017, the SANDF launched a range of new military vehicles to be used for border patrols. These mobility packages consisted of cross-country vehicles, which made provision for a small number of personnel, and the manoeuvrability and agility to cope with operational demands in the border environment. The initial rollout of these vehicles took place at the KwaZulu-Natal-Mozambique border (DefenceWeb, 2017; CSIR, 2017).

Apart from lack of capacity, there is the issue of the borderline environment. Border posts experience challenges of understaffing and a lack of resources, and outdated technology to execute border control processes thus resulting effectively and efficiently in slow processing and lax border controls (Van Lennep, 2019). Similar sentiments are held by Mahlangu and Obioha (2015) when they state that due to the high influx of people and goods, and infrastructure challenges at borders, it is impossible for border authorities to search each person and all the goods entering or leaving the country. Dithebe and Mukhuba (2018) recommend the filling of vacancies

at border posts and the provision of training to border officials. The authors (2018) further suggest the provision of adequate resources to manage the scourge of illegal migration in South Africa.

2.6.7 Corruption

Corruption in the border environment commonly falls within public sector corruption and often goes together with the trafficking and smuggling of illegal migrants. Border corruption in the context of migrant trafficking and smuggling could occur through direct or indirect means. The process of migrant trafficking and smuggling, and its numerous stages, create endless corruption opportunities for public officials from different state border and law enforcement authorities. Criminal organisations responsible for the trafficking and smuggling of illegal migrants often pay money to public officials as a way of undermining and neutralising the entire system of law enforcement designed to fight illegal migration. This, in turn, has destructive effects on the efficiency of the entire migration control and law enforcement system and further impacts on civil society's trust in the system (Agbu, 2003; Borjas & Crisp, 2005; Spencer, Aromaa, Junninen, Markina & Viljanen, 2006).

Similar sentiments are held by Merkle, Reinold and Siegel (2017). They state that corruption is of interest to migrant smugglers and human traffickers, as the use of corrupt practices to secure the compliance of border and law enforcement officials allows smugglers and criminal elements easy passage across national borders, and it further legitimises their illegal activities. Shelley (2018) refers to corruption related to human trafficking as “globalised corruption”, which significantly contributes to the rise in global human trafficking activities. Holmes (2009) argues that there is a strong correlation between corruption and human trafficking as human trafficking tends to flourish through the corruption of public officials. However, the author (2009) warns that that evidence in this regard is scarce, and that arguments on this correlation are based on assumption.

Corruption by public officials can be linked to human trafficking and smuggling in various forms. In this regard, public officials could be involved in a variety of corrupt

activities. These include operating human trafficking and smuggling operations; participating in human trafficking and smuggling operations by providing traffickers with information about planned law enforcement and migration control operations; turning a blind eye to illegal border crossing activities; irregularly issuing travel documents to trafficked and smuggled migrants; ignoring false travel documents and impostors; refusing to follow leads on human trafficking and smuggling; and participating in illegal post-trafficking and smuggling activities like forced labour and prostitution. Corruption in human trafficking and smuggling seeks to lower the risk of detection at one of the most vulnerable parts of the journey and to circumvent border surveillance efforts (Holmes, 2009; International Bar Association, 2016).

Corruption in the border environment is not limited to migrant smuggling and trafficking. It is also relevant to other organised criminal activities. Criminal organisations and individuals could use corruption to smuggle cigarettes; traffic drugs; traffic illicit good; smuggle stolen vehicles; smuggle goods; and launder money. Criminal organisations could also use corruption to receive information from border officials; persuade officials to obstruct investigations into any allegations of border control violations; and cause officials to provide false alibis (Centre for Study of Democracy, 2012; OECD, 2015; OECD, 2016).

Corruption in the border environment is a global phenomenon. European countries also experience the challenge of corruption on its borders (Europe Institute for Crime Prevention and Control, 2006). The practice of corruption at immigration checkpoints across the EU can be classed into organised crime, petty corruption, and administrative corruption like the types of corruption that occur in other large institutions. Organised crime-related corruption includes the selling of information to criminal groups facilitating passage of illegal migrants, not reporting suspicious travel documents of migrants, and obstructing investigations. Petty corruption, on the other hand, might include providing a “normal passage fee” to speed up border traffic or waive minor irregularities, including petty smugglers paying small bribes to ensure problem-free passage or seeking payment for allowing the passage of known or wanted individuals (CSD, 2012; Rusev, 2013).

The United States of America (USA) also experiences problems with corruption perpetuated by its officials at border posts. According to Becker and Marosi (2011), 132 customs employees were indicted or convicted of corruption related charges since October 2004. The rise in border corruption is attributed to the abundance of moneymaking opportunities, which border agents and customs inspectors are exposed to. This has resulted in many officers turning their government jobs into illicit riches. Moreover, stricter border controls, such as the addition of fences, sensors, and drones along the US borders, have resulted in an increase in corruption among border officials. Some border officials are said to have sought employment in the border control environment to enable smuggling operations (Wells, 2019; Jancsics, 2019).

In Asia, despite efforts by the Border Management Programme for Central Asia (BOMCA) to train border guards, provide key technology and infrastructure at borders, and implement the joint management of borders, corruption remains rampant at borders in Central Asia (Gavrillis, 2009). According to the UNODC (2014), contraband, drugs, precursor chemicals, weapons and narcotics smuggling contributes significantly to the high level of corruption at ports of entry in Central Asia. The scourge of corruption at ports of entry in Central Asia is further attributed to the fall of the Soviet Union, which hindered good governance and encouraged illegal activities to flourish unabated (UNODC, 2014; Gavrillis, 2012; UNODC, 2019).

Like Europe, the USA and Asia, South Africa faces the challenge of corruption at its borders and ports of entry. With the DHA being the entity responsible for facilitating the movement of people into and out of South Africa and SAPS also being responsible for border law enforcement at ports of entry in South Africa, Corruption Watch reports that corruption in SAPS went up from 6.3 % in 2018 to 9.2 % in 2019 (Corruption Watch, 2019). The immigration service was further identified as a corruption hotspot, accounting for 5% of the reports received by Corruption Watch in 2014 (CW, 2014). Moreover, according to Lennep (2019) and Latham (2020), corruption at the Beitbridge Border Post, which is the major land border post in South Africa, is so rampant that travellers are expected to pay bribes to cross the border. Similar sentiments are held by Brock (2017), when indicating that many migrants in South Africa have fallen prey to corruption and violence, where some are required to pay bribes to law enforcement and immigration authorities in order to stay in the country.

Although the study by Mabudusha (2014), which sought to explore the experiences of SAPS in dealing with undocumented foreign nationals, did not find a relationship between corruption and illegal migration at selected border posts in South Africa, it found that the experiences of undocumented migrants crossing through the Beitbridge, Limpopo, and Ficksburg border posts were good. The study further found that many undocumented migrants were known to the police and that they could cross back and forth over the border without the police intervening. Mabudusha (2014) also noted that whilst the police were overwhelmed by the number of undocumented migrants at the identified border posts, they were more sympathetic to undocumented migrants than police officials in areas situated far from border posts, such as in Johannesburg. This was attributed to the close family ties between the undocumented migrants and families living closer to those border posts. Thus, undocumented migrants received support from both the border community and the police. These practices are directly related to acts of corruption, as mentioned earlier in this section, that border officials often ignore illegal border crossings. There have also been media reports on how easy it is to cross South Africa's borders by bribing officials. Through its investigation, eNCA exposed how easy it was for border jumpers to enter and leave South Africa at the Beitbridge border area where R1000 was enough to secure safe passage in or out of the country through illegal means (Businesstech, 2020b).

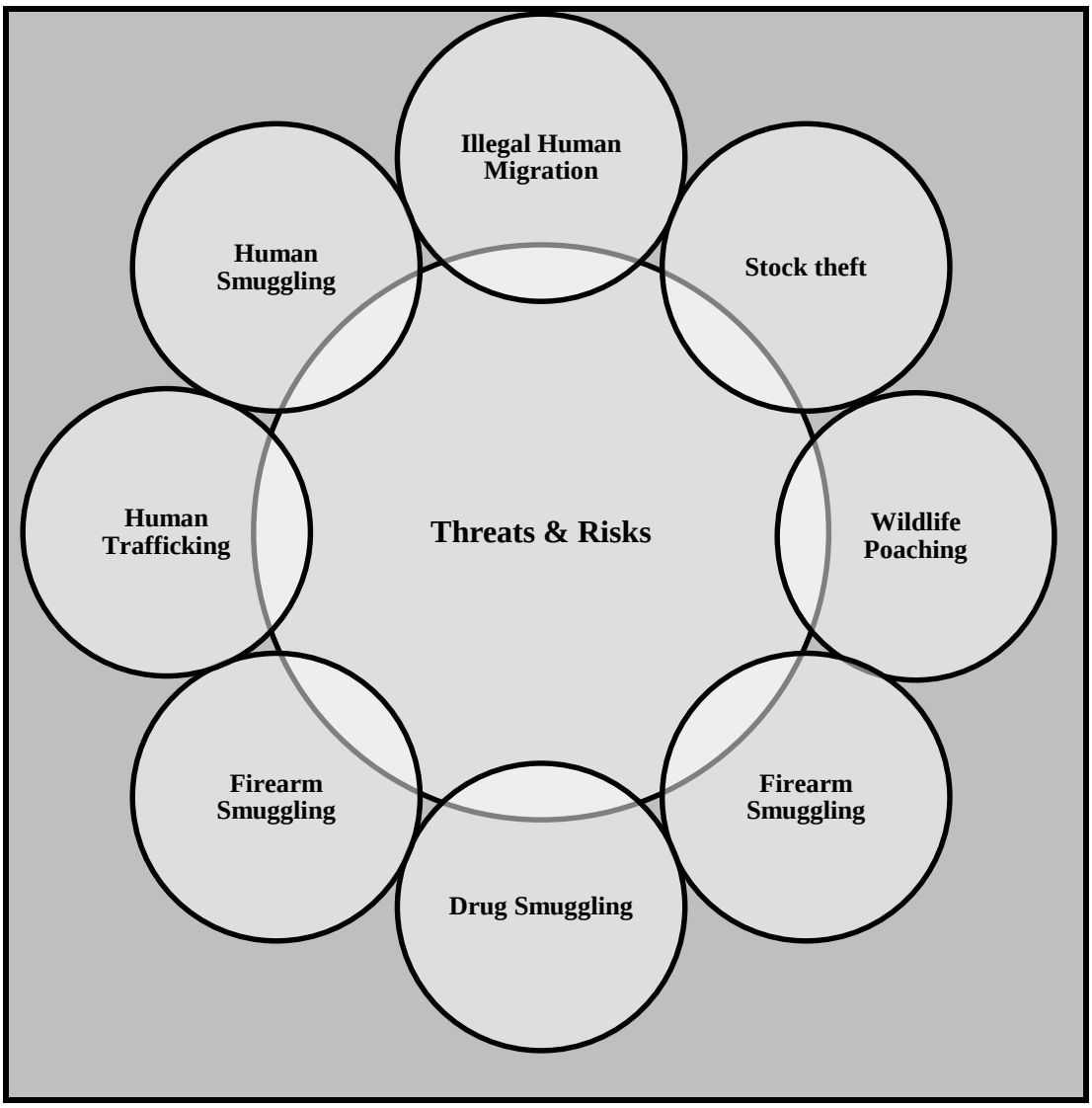
2.7 Implications of ineffective border security in South Africa

Figure 2.4 illustrates the most common manifestation of cross-border crimes at South African borders, which are illegal migration, human smuggling, human trafficking, wildlife poaching, firearm smuggling, drug smuggling, and the smuggling of other natural resources. Other threats, which are not necessarily prevalent but could arise because of poor border controls, are those to national security such as terrorism. The below mentioned threats and risks are not exhaustive but merely highlight the most common threats and risks experienced at South Africa's borders.

Illegal cross-border activities, such as illegal border crossings, transnational crimes, human trafficking, and smuggling, as well as wildlife poaching and trade, are prevalent

in South Africa. The length and distance of South Africa's land borders; variations in the land border terrain; inadequate resources; and a lack of cooperation among border authorities make it difficult for border security authorities to monitor and control South Africa's international land borders using conventional means, such as vehicle and foot patrols (Minnaar, 2001; Martin, 2018; SA News, 2017; Business Live, 2016; Heitman, 2014; Baker, 2009). Similar sentiments are held by Anderson (2008), Martin (2018) and Mahlangu (2016). They state that transnational criminal activities (e.g., human smuggling and trafficking, stock and vehicle theft, terrorism and the smuggling of goods, arms, and narcotics) are characteristics of international migration, and South Africa is not immune to these criminal threats and risks.

Figure 2.4 : Threats and risks to border security.



Source: Researcher's own illustration

According to Baker (2010), the threat of a conventional war against South Africa is so small to the extent that it can be discounted. Considering this, Baker (2010) and Martin (2011) caution that South Africa needs to be prepared to address the possible threats of terrorism, crime, and social unrest. As indicated earlier in this study, transnational and immigration related crimes in South Africa are a cause for concern. The prevalence of these criminal activities is exacerbated by the nature and challenges of border security, as discussed earlier in this study. These factors can be summarised as the vast and porous South African borders; variations in the border terrain; human and physical resource constraints; and poor coordination and execution of border security management activities by government departments and agencies within the border security environment.

The ability of a state to exercise control over its borders is of paramount importance for key national priorities such as stability and national security. It also enables a state to discharge its responsibilities within its territory and further enables a state to achieve its political, legal, and economic objectives. Thus, the issue of effective border security, which is a critical factor of border management, becomes a key national security problem for consideration to any state, including South Africa. The earlier discussion on the South African border environment provided a synopsis of the border challenges experienced at various border areas in the country. The borders between South Africa and Mozambique, Zimbabwe, Lesotho and eSwatini appear to be more problematic, compared to the borders between South Africa, Namibia, and Botswana, which are much quieter. Wiese (2019) attributes this to the legal and institutional architecture present in the neighbouring countries. That is, if a neighbouring country has a strong institutional and legal infrastructure, such as is the case in Botswana, transnational crimes (such as stock theft) would be less of a problem than in a country with a more laissez-faire approach, such as is the case in Lesotho.

2.7.1 Illegal human migration

The most frequently recorded literature on the consequence of poor border management and ineffective border security and control is on the topic of illegal human migration. This elevated interest could be attributed to the fact that most, if not all

cross-border crimes (apart from cybercrimes), are mainly perpetuated by humans and in that process, a country's migration laws are usually violated. In the South African context, one of the most documented challenges of border security is illegal migration, which occurs in several ways, including, but not limited to, jumping the porous and poorly monitored South African borders.

Collecting reliable data on illegal migration remains a serious challenge. This is due to the clandestine nature of this phenomenon; the difference in the definition of what an illegal migrant is; challenges with data sources on which estimates are based and the collection methods; and variances in legislation across countries, which makes the task of estimating the number of illegal migrants residing in each country extremely difficult (Clarke, 2000; Karagueuzian & Verdier-Chouchane, 2014). Other aspects, which make it difficult to have accurate records, are the country's porous borders; corrupt officials; circular migration; poor recordkeeping; and the manipulation of data by government and non-government agencies in order to secure funding (Landau et al., 2013).

Illegal migration statistics normally consist of quantitative estimates of both the number of the illegal migrant population and the estimates of illegal entries. Considering this, scholars agree that the number of illegal immigrants entering South Africa is on the rise. Although the exact number is difficult to gauge, it has been said that the lack of formal mechanisms to effectively manage migration has been the major cause of the rise in the inflow of illegal migrants into South Africa post-apartheid (Futo & Tass, 2001). Crush (1999) argued that the number of illegal migrants had been exaggerated by South African government agencies and SAPS to achieve political gain. The author (1999) further suggested that government officials used the exaggerated numbers to paint a picture of unacceptably high levels of illegal migrants, who negative influenced the social and economic interests of South African citizens. However, it is argued that the data published on illegal migrants is often unrealistically low, decentralised, and contradictory. Consequently, this has an impact on attempts by scholars to contribute to the scholarly debate on the determinants of migration.

Likewise, conventional accounts of African migration tend to focus more on Eurocentric destination countries at the expense of the role African states play in shaping the aspect of global migration (Flahaux & De Haas, 2016). Given this, statistics by SAPS on the years 2007 to 2009 suggest that there were some three to six million irregular migrants in South Africa (Segatti & Landau, 2011). Furthermore, according to the African Center for Migration Society (ACSM), the total number of foreign nationals (inclusive of both regular and irregular migrants) is less than four percent of the total South African population, which was estimated at 53.7 million in 2013 (Landau, Segatti & Misago, 2013). Budlender (2013) suggests an upward trend of illegal migration into South Africa, further indicating that in 2013, the number of undocumented migrants living in South Africa was estimated at less than three million people.

Recent estimates suggest that the number of illegal immigrants residing in South Africa amount to between 10 and 15 percent of the total South African population of approximately 58 million. This translates to a population of between 5.8 and 8.7 million illegal migrants. These figures do not only relate to migrants not in possession of the required visas or permits issued in terms of the South African immigration laws, but also refer to migrants who are in possession of fraudulent or fabricated visas, permits, or identity documents, and those who are in possession of lapsed visas or have contravened their visa conditions (Eisenberg, 2019).

Another method used to assess the extent of illegal migration in a country would be the detection and deportation of illegal migrants. The numbers of deportations in South Africa fluctuated between 2003 and 2011. There were over 1.4 million deportations between the 2003/2004 and the 2010/2011 financial years. According to these statistics, there was a sharp decline in the number of deportations between the financial years 2008/2009 and 2010/2011. This decline is attributed to general amnesty measures introduced by the South African government to Zimbabwean nationals in a form of the Dispensation for Zimbabwean Permits (commonly known as DZP), and the Lesotho Special Permit (known as LSP) (Lennep, 2019). Statistics provided herein show the continuous and changing patterns of irregular migration over time in South Africa, which could make the prediction of future trends more difficult.

In addition, official statistics released by the DHA between 2012 and 2016 indicated that there were 369 726 deportations over the said period. The number of deportations fluctuated between 2012 and 2016. However, there was a sharp drop in deportations in 2016, compared to the highest point in 2013. Most irregular migrants come from countries that South Africa shares borders with. For example, 88 percent of the total number of migrants who were deported between January 2012 and December 2016 came from Mozambique, Zimbabwe, and Lesotho (DHA, 2017).

Even in the absence of accurate and reliable data on illegal migration into South Africa, the direct and indirect estimates discussed in this study indicate the prevalence of this dilemma in the country. Available literature also suggests that illegal migration into South Africa will continue to be a problem due to the dire economic and political conditions in migrants sending countries, especially neighbouring countries. Moreover, better economic, and political conditions in South Africa, when compared to other African countries, will continue to attract both legal and illegal migrants into the country. Moreover, the porosity of South Africa's borders will continue to be a contributory factor to the problem of illegal migration into the country (Crush, 2011).

Additionally, with several generic factors driving both regular and irregular migration into South Africa, it is anticipated that the rate of undocumented migrants into the country will continue to grow because of additional unique factors. The factors include the informal movement of persons across South Africa's borders, which have become part of the country's history; colonial boundaries that separated communities across South Africa's borders; the absence of border policing pre-1960, which encouraged illegal migration to flourish; and the mining system that became the only form of formal foreign labour recruitment. This encouraged the informal movement of migrants for the agricultural and services sectors. Additionally, South African employers (especially in the construction and service sectors) preferred to employ non-South Africans. Considering the latter, employing undocumented migrants allows employers to disregard applicable labour laws; to pay below minimum wages; and to neglect the payment of employment benefits. The porosity of South Africa's borders and its policy measures, which make it harder to work legally in the country, also contribute to the clandestine and illegal inflow of migrants (Crush, 2011).

2.7.2 Transnational organised criminal activities

The significant growth in trade, and communication and transportation technology, has not only provided the African continent with opportunities to integrate with the global community and to enhance economic growth and development, but also provided a platform for illicit opportunities. Africa has become a hotspot for transnational crimes due to weak governance structures, poor border controls, and rampant corruption. Post-apartheid South Africa and the transition phase, coupled with the removal of sanctions, also contributed to an upsurge in multinational crimes. These crimes include the illegal movement of goods; drug smuggling; weapon smuggling; and money laundering (Minnaar, 2010; Shaw & Reitano, 2013; DefenceWeb, 2020b). The discussion below will examine the most prevalent cross-border crimes in South Africa.

2.7.2.1 Transnational theft and smuggling of livestock

Livestock smuggling is a global phenomenon, and not new to South Africa. It not only occurs at the domestic level, but also includes cross-border livestock theft. There has been an increase in this phenomenon over the years. Livestock theft has a significant economic impact and costs the country billion of rand annually. Its impact is not only limited to the economy, but it also has a negative impact on food security and the agricultural economy. Moreover, livestock theft feeds into other cross-border organised crimes, such as human trafficking, drug and weapon smuggling. In turn, these criminal activities create illicit financial flows, which has financial implications for African countries as it is estimated to be worth some R700 billion annually. The borders most affected by livestock theft are the South Africa-Lesotho borders. Stolen livestock is often hidden along the mountainous border area and moved to Lesotho at a later stage, where they are rebranded and resold in South Africa. A similar method is applied to livestock stolen in Lesotho (Chelin, 2019; Dean, 2020; Dzimba & Matooane, 2005; Pule, 2013).

A major contributor to livestock theft is the porous and unsecured borders. The absence of or dilapidated fences along the borderline provide an opportunity for criminal syndicates to steal and move cattle easily across the borders. Moreover, the length of

the borderline and the mountainous terrain in the border area make it difficult for authorities to monitor the borderline; thus, providing opportunities for criminals to execute their criminal activities. In some instances, livestock theft does not occur in isolation. It is sometimes accompanied by other violent crimes against the bodily integrity and life of a person. Farm owners and workers are sometimes attacked and murdered during the process. Their vehicles are stolen, and, at times, their property is destroyed (Dean, 2020; Chelin, 2019). However, Wiese (2019) cautions that if a country neighbouring South Africa has a strong legal and policing structure, such as Botswana, cross-border crimes such a stock theft become less of a problem when compared to a laxer regime, such as in the case of Lesotho.

There has been an increase in the theft of livestock in the Eastern Cape and Free State, with irregular increases in North-West, Mpumalanga, and Gauteng. The extent of livestock theft in the Eastern Cape and Free State is considerably higher and more severe than in the other provinces. The provinces with the highest reported cases of livestock theft are the Eastern Cape, KwaZulu-Natal, and Free State. This could be attributed to the fact that livestock theft on the South Africa and Lesotho borders is higher than in other parts of South Africa. Some parts of the Eastern Cape, KwaZulu-Natal and the Free State border Lesotho and livestock is often stolen and transported to and from either side of the border. KwaZulu-Natal also borders parts of eSwatini and Mozambique, and it experiences high numbers of cross-border livestock theft (Maluleke & Dlamini, 2019; Martin, 2011; Pule, 2013).

2.7.2.2 Transnational poaching and smuggling of wildlife and other natural resources

The SADC region continues to experience the poaching of wildlife, which is linked to the high concentration of elephants and rhinos in Southern African countries. The high concentration of elephants and rhinos is compounded by the ever-increasing value and demand for ivory and rhino horns in the global market, especially in the East Asia, for use in traditional Asian medicine and as decorative objects. This exacerbates the poaching dilemma in the SADC region. Other problematic wildlife crimes in the SADC region and South Africa include the poaching and smuggling of live predators across

SADC borders to feed the growing market and demand for lion bone in the Far East. Poaching is not only executed by poachers from within the region, but it also involves poachers from other parts of the world, like Chinese nationals who operate in the SADC region. These poachers are sophisticated syndicates, who are militant and aggressive in their approach, and make use of high-calibre weapons. In some instances, they make use of low flying aircrafts to execute their heinous wildlife crimes. They are also able to cross borders with relative ease. Wildlife poaching is however not an isolated crime, as syndicates involved in poaching are also involved in other criminal activities like diamond and drug smuggling, cattle rustling, and human trafficking (Adam & McShane, 1992; Baruti, 2018; Gyimah, 2006; Maguire & Haenlein, 2015).

South Africa is not immune to the problem of wildlife poaching and is among the most vulnerable countries when it comes to wildlife related crimes. This is despite the increased focus and coordinated efforts by law enforcement authorities to deal with this crime. The unsecured border area in the South African border area, such as the area on the South Africa-Botswana border in the southern part of Botswana, allows poachers to operate with ease. The absence or minimal presence of border security authorities along the long and porous borders between South Africa and its neighbouring countries, including Zimbabwe, Botswana and Mozambique, and poor cooperation with neighbouring countries also creates an opportunity for poachers to operate (Baruti, 2018; Gaustadsæther, 2016; Griffiths, 2017; Lunstrum, 2014).

Additionally, the size of the border area with South Africa's neighbouring countries and the size of the Kruger National Park (KNP), where most rhino poaching takes place; the dense vegetation; and the mountains and thick forests make the task of patrolling and monitoring the border area extremely difficult. However, these conditions make it easier for poachers to operate in and out of the border area and the KNP without being detected. The position of the KNP, which is located on the border between South Africa, Mozambique and Zimbabwe, and the lifting of certain parts of the border fence during the establishment of the Great Limpopo Transfrontier Park make the KNP more vulnerable to transnational wildlife poaching and smuggling (Baruti, 2018; Gaustadsæther, 2016; Griffiths, 2017; Lunstrum, 2014).

Wildlife poaching has far-reaching implications, not only for the preservation of wildlife, but it also has a negative impact on the economy of rural communities in South Africa. This is because wildlife is a significant economic base for many rural communities and provides for the continuing sustainability of the tourism sector, especially for wildlife tourism. Moreover, the reduction in the populations of wildlife due to poaching hampers socio-economic development, both locally and internationally. It also has heritage implications for South Africans, as future generations will be deprived of the chance to experience wildlife and to benefit from the economic spin-offs of wildlife tourism. This is because South Africa is a preferred destination for wildlife tourism and is dependent on tourism as a major source of income (Griffiths, 2017).

Given the above, it becomes important not only to strengthen legislation, which deals with combating wildlife poaching, but also to strengthen border security in the affected areas. Considering that the landscape in the affected border areas makes it difficult to patrol and monitor the area and further considering the personal safety risks that border authority face when monitoring the wildlife-rich border area, it might be necessary to employ non-human alternatives to monitoring and control. In addition to the abundance of wildlife, South Africa boasts a wealth of precious metals, such as diamonds, gold, and platinum, which are also targeted by transnational criminal syndicates. The local syndicates are linked with larger international criminal syndicates in countries such as Russia, Nigeria, German, China, and India, which allow them to smuggle precious metals abroad. Most of the stolen precious metals are stolen by mineworkers who are in cahoots with criminal syndicates. Precious metals are also stolen by illegal miners. South Africa is further used as a transit country for natural resources smuggled from other SADC countries (Gastrow, 2003; Coetzee & Horn, 2006).

2.7.2.3 Transnational theft and smuggling of vehicles

Cross-border vehicle smuggling remains a huge challenge in South Africa. It is not a new phenomenon and has been in existence since the opening of South Africa's borders in 1994, which increased the freedom of movement of people and goods between South Africa and neighbouring countries. According to Irish (2005), South Africa became a

major source of smuggled vehicles, and it accounted for some 98% of the vehicles that were acquired through illicit means within the SADC region during the late 1990s into the early 2000. Some of the smuggled vehicles included four-wheel drive luxury vehicles and stolen or hijacked trucks, which were ultimately smuggled across the long and porous South African land borders (Irish, 2005).

Vehicle smuggling across South Africa's land borders remains prevalent at most of the South Africa's land borders. The smuggling of vehicles across the land borders at places, other than designated ports of entry, is one of the methods used by criminals to move vehicles across borders. Other methods include using fake and duplicate vehicle ownership documents and the fraudulent removal of vehicles across the official border posts with the permission of the owner. In other instances, syndicates use export permits or temporary import permits to smuggle vehicles across designated ports of entry. Criminal syndicates will often exploit weaknesses present at ports of entry and complacent officials at ports of entry (Baruti, 2018; Gaustadsæther, 2016; Griffiths, 2017; Lunstrum, 2014).

The border areas between South Africa-Zimbabwe, South Africa-Mozambique and South Africa-eSwatini experienced significant challenges relating to vehicle smuggling along these borders. Syndicates take advantage of the porous borderline and the absence of physical barriers in most parts of the South African borderline. In the South Africa-Zimbabwe border area, the Beitbridge port of entry and the land borderline are the only direct routes from South Africa to Zimbabwe by land. These two countries are separated by a fence and the Limpopo River. However, these barriers have not been effective in thwarting efforts by criminal syndicates to execute their cross-border criminal activities. Some parts of the border fence have been cut to allow for the crossing of stolen and hijacked vehicles. Vehicles are moved across the Limpopo River, especially during the dry season when the water levels are very low. In recent times, syndicates have resorted to using donkeys to pull stolen vehicles into Zimbabwe across the Limpopo River (BBC, 2017; TimesLIVE, 2017; Maluleke & Dlamini, 2019).

2.7.2.4 Transnational smuggling of firearms and explosives

There has been an increase in the smuggling of industrial explosives across South African borders over the years, especially at the South Africa-Zimbabwe borders. These explosives are mainly sourced from the collapsing mining sector in Zimbabwe and smuggled into South Africa to be used in criminal activities, such as in illegal mining operations, cash-in-transit heists, and Automatic Teller Machines (ATM) bombings (Geldenhuys, 2019). In addition to the smuggling of explosives into and out of South Africa across South Africa's land borders, the country also experiences the smuggling of firearms across its borders. This crime has been in existence pre-1994 when a variety of weapons were smuggled into and out of South Africa destined for political and liberation movements. Some weapons were smuggled through designated border posts concealed inside the door panels of vehicles, in suitcases, and in fuel tanks. Firearm smuggling activities continued post-1994 as the socio-economic and political situation is South Africa changed and enabled criminals who had contacts abroad and were familiar with pre-1994 firearm smuggling methods and routes (Gamba, 2000).

The landscape of most SADC countries also provides easy opportunities for the cross-border smuggling of firearms. As SADC countries integrate and share the movement of goods and people, they also share cross-border criminal activities, such as the smuggling of firearms, vehicles, and drugs. Moreover, the rise in the illicit firearm trade is attributed to the vast and porous South African sea and land borders (Mills & Herbst, 2007; Bopape, 2014). Minnaar (2001) and Mothibi, Roelofse and Maluleke (2015) state that even though it is a difficult task to prioritise specific crimes, drug, vehicle, and weapon smuggling are regarded as some of the most serious crimes facing South Africa. These crimes are all linked to an increase in the movement of people and goods, and the porosity of South Africa's borders.

2.7.2.5 Transnational smuggling of drugs, cigarettes, and goods

The smuggling of drugs to or through South Africa has been a major challenge for the country since the dawn of democracy. Drug smuggling was counted among the most prominent transnational crime in South Africa post-1994 as the country positioned

itself as one of the manufacturers, producers, and users of narcotics both continentally and internationally. South Africa is counted among Malawi, Nigeria, Kenya, and Tanzania as one of the top African countries producing the bulk of cannabis (dagga) intercepted and seized abroad (Pienaar, 2015).

Illicit drugs such as heroin, dagga, and cocaine, including cigarettes, are smuggled through South Africa's borders. Although not necessarily smuggled only through designated land, sea and aviation ports of entry, illicit goods are also able to reach the shores of South Africa through its porous land borders. South Africa has one of the largest markets for drugs in Africa and has experienced a significant influx of drugs over the years. Heroin, for example, is usually sourced from Afghanistan, via Pakistan to the eastern coast of Africa, where it is destined for either African countries or larger markets in Europe (Shaw, 2017; Haysom, 2019).

Dagga is mainly smuggled from neighbouring Lesotho through the Free State, Eastern Cape, and KwaZulu-Natal ports of entry and illegal crossing points along the land borders. In remote areas, dagga is transported by foot or horses; once it reaches South Africa, it is loaded into vehicles and transported to various areas in the country. Mozambique, with its long porous coastline, is vulnerable to drug smuggling syndicates and it serves as a preferred transit country for those who want to smuggle drugs into South Africa. Drug smuggling syndicates prefer to use land borders to smuggle drugs because of the lax border controls and corruption at South Africa's border posts. In addition, syndicates will fly from abroad into neighbouring countries (such as Mozambique) and enter South Africa through its land borders (Shaw, 2017; Mojaki, 2018; Kempen, 2019).

Bruwer (2017) mentions that landward seizures of consignments of drugs in countries like Tanzania, Kenya and Mozambique are an indication that drugs are broken up when they reach the shore and then rerouted to other destinations by road. By implication, this sheds light on the detection and seizure of smaller amounts of heroin, which are transported by land in cars and trucks from neighbouring Mozambique to South Africa. This situation calls for increased vigilance and monitoring of South Africa's local ports and international land borders. Similarly, illicit cigarettes and tobacco are mainly smuggled from Zimbabwe and Mozambique into South Africa through designated

border posts and illegal crossing points along the South Africa-Zimbabwe-Mozambique borders and sold in illicit markets at a cheaper price (Chelin & Nyoni, 2020; Geldenhuys, 2019; Kuyedzwa, 2018).

The smuggling of cigarettes is often undertaken by armed and violent criminal syndicates in the South Africa-Zimbabwe border area. Zimbabwe produces superior tobacco leaves; hence, it is the main source of illicit tobacco in the SADC region. The South Africa-Zimbabwe-Mozambique borders are also vulnerable to cocaine smuggling. This is due to the positioning of the Beitbridge border where it connects South Africa to the rest of the continent by road and the porous coastline of Mozambique, which is exploited by international smuggling syndicates (Chelin & Nyoni, 2020; Geldenhuys, 2019; Kuyedzwa, 2018;).

Tobacco smuggling into South Africa took place even before democracy and the re-exposure of the country to the global market. This phenomenon also existed before tobacco control measures were implemented in democratic South Africa. This criminal activity has a significant impact on the South African economy. The smuggling of tobacco affects SARS' ability to collect the applicable taxes and implement tobacco control policies. The smuggling of tobacco is part of a larger illicit economy, which also involves the smuggling of other goods and commodities, including movies and music, petroleum, clothing and textiles (Hubschle, 2006; Joossens, Merriman, Ross & Raw, 2010; Chelin & Nyoni, 2020).

2.7.2.6 Transnational trafficking and smuggling of persons

Many institutions responsible for managing migration indicate the connection between poor border controls, illegal migration, and organised criminal activities, such as the trafficking of women for forced prostitution. Many migrants are removed from their countries of origin by either force or deception. Many of them are exploited at a later stage, through direct threats of violence or they are compelled to pay their alleged debts for smuggling fees. Other smuggled illegal migrants are forced into prostitution or are made to work long hours in various industries in the transit or destination countries. The dilemma of trafficking in persons and smuggling is compounded by the potential

for huge profits for criminal syndicates and the relatively low risk of detection and prosecution when compared to other transnational organised criminal activities (Neske, 2006; Tarnu, 2015; Vayreynen, 2005).

Moreover, migrant trafficking and smuggling is not a criminal activity, compared to other organised crimes such as drug trafficking. This is due to the involvement of the organisation of smugglers, as well as the role migrants play in the process. The nature of these criminal activities involves a series of networks across national borders. Cross-border organised crimes are not limited to migrant trafficking and smuggling, drug trafficking and terrorism, but include other organised criminal activities like the illegal trafficking of weapons, the smuggling of stolen vehicles, the trafficking of precious metals, and the involvement in wildlife crimes (Vermeulen, Van Damme & De Bondt, 2010).

Open and unprotected borders have become a conduit for criminal activities and have allowed many criminal organisations to operate without any hindrance across borders. One of the social and security problems caused by porous borders is the issue of human trafficking. Even though there are measures in place to ensure border security in South Arica, the country's borders provide many opportunities for criminal activities. One such opportunity is the trafficking and smuggling of persons. Border authorities are unable to cover the entire border area and geographical barriers, such as rivers, are crossed easily by migrants and traffickers. Traffickers are also able to create new trafficking routes to avoid detection and, at times, collude with border authorities (Molemma, 2013). However, it is difficult to measure the extent of human trafficking in South Africa due to the limited availability of human trafficking data. Minimal and unreliable data is made available by role players in the criminal justice system (Mofokeng & Olutola, 2014). Due to its economic position and dominance in Africa, South Africa attracts illegal migrants from large parts of the African continent and human traffickers due to the poor socio-economic and political conditions on the African continent and other parts of the world, as discussed earlier in this study. Thus, South Africa has become a source, a transit, and a destination country for human trafficking (Molemma, 2017).

The Human Science Research Council (HSRC) (2010) indicates that human trafficking victims recruited from other parts of Africa enter South Africa through its land borders, which include the land borders with Zimbabwe, Mozambique, eSwatini and Lesotho. However, there is no information available regarding human trafficking in Botswana and Namibia. This is attributed to the more stable nature of these two counties, as opposed to their SADC counterparts. Human trafficking does not only occur in neighbouring countries. Migrants are trafficked from other parts of Africa (such as the Horn of Africa) and from other continents (such as Asia) and transported to South Africa through the land borders with neighbouring countries under the pretext that they will be offered employment in various sectors (e.g., in restaurants, on farms, and as domestic workers), but they end up being sexually exploited or abused.

Closely linked to human trafficking is the problem of human smuggling. They both involve organised criminal organisations who facilitate and transport persons to other territories. The only difference is that human smuggling is voluntary and there is no coercion and deception, and the person being smuggled willingly pays the smugglers money or some undue benefits to enter another country illegally. On the other hand, trafficking as earlier discussed, involves deceit and exploitation. Incidents of human smuggling are common at South Africa's borders. These activities are rife during peak seasons, such as over Easter Weekends and during the festive season. Smuggled persons often feature in the category of illegal migrants or undocumented persons. Smuggled migrants often make use of the services of smugglers because they do not have the necessary documents to travel to and enter South Africa. They are smuggled into South Africa from as far as Somalia and Ethiopia through Kenya, Tanzania and Mozambique (Kanko, Bailey & Teller, 2013; IOM, 2014; Marchand, Roosen, Reinhold & Siegel, 2016).

The smuggling of migrants involves mainly smuggling syndicates, which consist of ringleaders, facilitating agents, drivers and other agents who work in large separate networks to transport migrants to and from South Africa. Smuggled migrants often spend longer periods unsheltered and are transported under unsafe conditions; and are sometimes dumped in remote areas and lured into dangerous situations where they suffer financial and sexual exploitation and abuse. Hunan smugglers in the SADC

region appear to be generating large profits out of their criminal activities at the expense of human lives (Torkelson, 2011; IOM, 2013; UNODC, 2016).

2.7.3 Threats to national security and public safety

Ineffective border security and control contribute to illegal migration, as discussed earlier. In turn, illegal migration is a diverse and complicated phenomenon with multiple security implications, not only for states, but also for illegal migrants (Koser, 2005). Although there is no evidence of specific incidences of illegal or clandestine migration and their implications for national security and public safety in South Africa, the literature emphasises the impact of these factors on national security and public safety, especially in developed countries, such as the USA, and in Europe. Illegal migration ranks high on the international security agenda and scholars have found it difficult to ignore the link between clandestine migration and national security in this interconnected global setting. This aspect has seen policymakers in developed countries increasingly making links between their migration policies, border control measures, and national security (Sassen, 1998).

It also follows that states, South Africa included, have a sovereign right to control who and what moves across their borders, and by circumventing and undermining border control measures, illegal migrants therefore threaten the sovereignty of a country, and to an extent, threaten the national security of that country. Similar sentiments are advanced by Rudolf (2003) when the author mentions that some experts regard international migration flows as an event, which overwhelm the state capacity to maintain its sovereignty across a number of areas; thus, rendering its security vulnerable, especially in the presence of large undocumented and unaccounted for migrant stocks. Thus, preventing illegal migration is fundamental to reasserting the full sovereignty of a state and ensuring national security (Koslowski, 2004). However, Koser (2006) warns that this debate is a sensitive one and requires careful analysis before supporting assertions that illegal migration has direct implications on national security. The author (2006) further argues that although illegal migration might in certain situations threaten state sovereignty, the overemphasis of this link might

overlook other equally important matters linked to illegal migration, such as factors that have to do with societies and migrants themselves.

Closely connected to factors of interest to societies, various authors state that undocumented migrants might hide their health status to avoid detection of their status of illegality and the possibility of repatriation should they report to health facilities; thus, endangering the health of societies in general, and specifically in cases of communicable diseases. This, however, becomes an issue of their survival in the host country more than it is an issue of deliberately endangering public health and safety (Carael, Cleland, Feery & Ingham, 1995; Hussein, 2000; Munsiff, 2007).

Considering the above, it is important to explore the potential impact that poor border security controls might have on national security and public safety in South Africa, examining various international experiences and local perceptions of poor border control and its consequential factors of illegal and clandestine migration. One of the major security incidents, which raised concerns regarding the relationship between cross-border mobility and international terrorism, was the ability of the September 11 hijackers to enter, live, and train in the US in preparation for carrying out terrorist attacks on the World Trade Center and the Pentagon in 2001. Considering these factors, it has been noted by Smith and Luther (2006) that the al-Qaeda network exploited weaknesses in the US migration control systems. It is further suggested that terrorists might have used illegal migration channels and manipulated asylum seeker processes to enter the US (Huysmans, 2006). Besides, a study by Nowrasteh (2016) sought to present the first terrorism risk analysis of the visa categories foreign-born terrorists used to enter the US. The study found that foreign-born terrorists who entered the US, either as immigrants or tourists, were responsible for 3024 or 88% of the 3432 murders committed by terrorists on US soil from 1975 to 2015. The study further predicted that, based on the analysis of available statistics, the chances of a US citizen being murdered by an illegal migrant is 1 in 10.9 billion per year, as opposed to 1 in 3.9 million of murders committed by migrants who hold a mainstream type B visa.

In another international observation, the issue of migration topped the security agenda in Europe throughout the 1930s (Adamson, 2006; Rezouni, 2010). Adamson (2006) indicates that the bombings in Madrid in 2004 and in London in July 2005 sought to

reinforce what Europe perceived as a link between migration and terrorism. Similarly, earlier incidents, such as the various attacks in the 1990s in several Western European states by the Kurdistan Worker's Party and the 1995 bombing of the Paris metro system by Algeria's Armed Islamic Group, had already raised concerns on the relationship between migration and security. However, Orrenius and Zavodny (2019) argued that there was inadequate evidence to confirm that there was a direct link between illegal immigration and crime in the USA. They (2019) further stated that studies had shown that migrants were less likely to commit violent and property crimes than US citizens.

In the South African context, Danso and McDonald (2000) acknowledge that there is the increased involvement of migrants in criminal activities, but there is no conclusive evidence that foreigners are excessively involved in criminal activities in South Africa (Landau & Segatti, 2009). Hussein (2000) states that there is subjective evidence suggesting a link between illegal migrants and criminal activities, such as armed robbery, drug trafficking and money laundering. According to Hussein (1996), undocumented migrants were implicated in 14% of crimes committed; in 1996, 152 migrants were involved in commercial crimes valued at R518 million, which represented 19.6% of commercial crimes at the time. Although not directly related to the issue of illegal migration, they were related to the uncontrolled flow of migrants into South Africa.

A study by Omeokachie (2013), which sought to investigate the extent to which large flows of refugees have an impact on security in South Africa, suggested that the presence of large numbers of refugees had serious security implications on both the state and South African citizens. The study found that issues of concern to the South African authorities and citizens regarding the presence of large numbers of refugees related to political, economic, social, and environmental issues. The study further found that clandestine migration was often blamed for the spiralling crime levels in South Africa, in particular crimes such as drug trafficking, smuggling rings, weapon smuggling, prostitution, human trafficking, and confidence scams.

Considering the above discussion, Koser (2008) argues that the conclusion that there is a direct link between illegal migration and national security implications should be supported by careful analysis considering the sensitivity of the topic of migration. The

author (2008) further states that this notion needs to be corrected through a careful and objective analysis and presentation of available supporting evidence and concerted dialogue between governments, the media, and citizens. This argument could be linked to the earlier discussion that it is often difficult to determine the numbers of illegal or irregular migrants in a particular country. Thus, the perception that state sovereignty is at a risk of being overwhelmed by a massive influx of migrants cannot be based solely on unreliable figures of illegal migrants in a particular country. In this instance, Koser (2005) holds the view that the political significance of illegal migration generally outweighs its numerical significance. Nevertheless, the author (2005) warns that another problem related to extreme statements on illegal migration is the instant reaction and denial by civil rights group and asylum advocacy groups of any wrongdoing by illegal migrants. Against this background, Koser (2005) suggests an objective debate, which disregards both unfounded perceptions and deals with realities associated with illegal migration.

The exaggerated focus on the link between migration and national security could also mean that other issues of equal importance for states, societies, and migrants themselves are overlooked (Dannreuther, 2007). Koser (2010) asserts that the link between illegal migration and national security is more relevant when it concerns organised crime and corruption, more if it is on terrorism and violence, particularly when smugglers and human traffickers are involved or when there is a battle for control over migrant labour once they have reached their destination. When it comes to the link between migration and crime, the study of the impact of illegal migration, which is caused by either poor border security or migration management, tends to focus mainly on two issues. Firstly, it focuses on the causal nature of the link between illegal migration and crime, and the extent to which data on the apprehension of illegal migrants changes with the volumes of illegal migration. Although there is no empirical evidence of a direct link between illegal migrants and crime, the association between illegal migration and crime could be of interest for three reasons; that is, illegal immigrants are said to be committing more crimes; illegal immigrants are more likely to be victims of crime; or they make use of smugglers to cross national borders, whom by doing so, commit further crimes against the state (Orrenius & Roberto, 2017; Blanchard, 2019). Moreover, Singer and Massey (1997) state that illegal migrants are more vulnerable and unlikely to report crimes committed against them; thus,

encouraging the further commissioning of crimes against them (Singer & Massey 1998).

Considering this, the researcher is of a view that the link between illegal migration, cross-border crimes, and the impact they have on national security and public safety cannot be ignored. The illegal movement of migrants across borders, such as in the case of human trafficking and smuggling, is a matter of public safety concern, like the smuggling of weapons, drugs, and precious metals. Smuggled weapons, for example, are used in the commissioning of serious and violent crimes in South Africa and could further be used to commit crimes against the state. Like smuggled explosives, they are mainly used in the commission of crimes, such as CIT heists, and they could be used in sabotage activities. Illegal mining activities and the smuggling of precious metals is another source of gang violence in South Africa, together with drug smuggling and dealing. These cross-border criminal activities might also be used to fund crimes against the state. It has been reported that South Africa is a potential transit point for terrorists, and it serves as a base for planning, training and financing terror operations (Schoeman, 2016).

2.8 Chapter summary

This chapter explored the South African border landscape and further highlighted several deficiencies and challenges related to the effective execution of the border security and control mandate in the country. Some of the challenges are related to the legal frameworks and governance structures and processes for border security and control; and others are related to inadequate capacity, equipment, and resources to deal with border security challenges in the country. Sociological factors, such as the unethical behaviour of officials and their competency levels (in some instances), also have a negative impact on how border security and control in South Arica is executed. These challenges and shortfalls render it difficult for the various government departments involved in border security and control to monitor and control the national territory; prevent and respond to a variety of security threats and vulnerabilities; enforce the law; and further ensure improved levels of human security. These socio-

technical aspects should be in place and complement each other for border security and control to be effective.

The discussion in this chapter also examined how ineffective border security contributes to cross-border crimes. It further highlighted how ineffective border security causes insecurity and how it spreads to the safety and security of citizens' lives and their properties. Ineffective border security also renders South Africa susceptible to other transnational crimes, such as terrorism. Therefore, it becomes important for borders to be adequately secured through the proper integration of the socio-technical aspects of border security and control. The next chapter of this study seeks to explore space technology as a potential non-human factor to enhance border security in South Africa.

CHAPTER 3

SPACE TECHNOLOGY FOR BORDER SECURITY

3.1 Introduction

The previous chapter highlighted the challenges experienced by border security authorities in controlling and monitoring South Africa's international land borders. The challenges of border security in South Africa relate to aspects such as governance structures and processes, which are evident in an unclear government policy position on border security; the constant changing of the lead department on border management matters; as well as poor coordination among border security authorities. Another significant border security challenge in South Africa, which is key to this research, is the socio-technical aspects of border control and monitoring. These aspects consist of less effective border surveillance strategies and human resource constraints. These challenges are exacerbated by the vastness of South Africa's borders; variations in the border terrain; and the dense or thinly populated border areas, which makes it difficult for border authorities to effectively control and monitor the country's international land borders.

It may be that the challenges of controlling and monitoring South African borders require border security authorities to adjust their border control and monitoring approaches. Considering this, there is an opportunity in line with international best practices to explore other methods of controlling and monitoring land borders and ultimately to enhance the detection, interception, and prevention of cross-border crimes such as drug and narcotics smuggling; wildlife crimes; illegal migration; human trafficking; and vehicle theft and smuggling. Thus, a proper combination of the socio-technical aspects of border security, such as the deployment of space-based technology, might be beneficial to South Africa's efforts to enhance border security. This also becomes critical for when South Africa is in the process of streamlining governance structures and processes through the establishment of a single entity, the BMA, which will be responsible for all aspects of border security in the country. Although the single

agency approach might be beneficial in addressing governance-related issues and challenges in the South African context, as identified earlier in this research, it might not necessarily fix the issues and challenges related to the technical aspects of border control and monitoring.

This chapter seeks to explore the use of space technology for border surveillance. It will examine the concepts of space technology and its general application in various industries and disciplines; and explore the development and application of space technology in both developed and developing countries. Also, this chapter will consider the application of space technology and explore the various space technologies that might be adopted for border control and monitoring. Furthermore, this chapter will look at the benefits and the limitations of employing space technology to enhance border security; it will also examine the aspects, which might need consideration before space technology can be employed as a viable option for border surveillance.

3.2 Concepts and applications of space technology

This research is multi-disciplinary in nature as it involves the field of management sciences; security studies; and space science and technology. Although it is not the intention of this research to critically explore and impart knowledge on the concepts and technical aspects of space science and technology, as it would be expected particularly in the scientific research of space science and technology, it is imperative to briefly discuss the concepts of space technology and their application in various industries globally before their application on border monitoring and control can be explored. Therefore, this section of the research provides a short and non-technical description of space technology and its application in several industries.

3.2.1 Concepts of space technology

Related to the definition of space technology is the concept of space science, which is defined as the study of all material and factors beyond the Earth's surface. It includes the study of the Earth's atmosphere and the boundaries of the universe. Space science often incorporates disciplines such as aerospace, astronomy, space medicine, aerospace

engineering, and astrobiology. Emanating from this, space technology could be regarded as technology in the field of satellites, together with the ground systems employed by space scientists to study the universe and the Earth, or to deliver a variety of services to users on the ground. Much of the technology in use today, such as mobile phone cameras, video enhancement systems, and clean energy technology, comes from space technology development.

Space technology plays a significant role in today's life as it contributes substantially to sustainable development by supporting the better management of natural resources; helping nations to improve their agricultural output; and by aiding disaster relief and peacekeeping operations through the provision of valuable information (Olla, 2009; SACSA, 2020). Likewise, the United Nations Economic and Social Council (ECOSOC) (2020) states that space technologies and the data derived from them have great potential to contribute directly or indirectly to achieving national or global goals. This is due to the incorporation of a variety of scientific disciplines including the exploration of space and the study of natural phenomena and physical bodies in outer space. Space technologies mainly refer to technologies that enable satellite earth observations, satellite positioning, and satellite communications. Spacecraft, aircraft, and Unmanned Aerial Vehicles (UAVs) are also important technologies and instruments of space science and technology. Technologies including those used for weather forecasting; global positioning systems; remote sensing; satellite television and communications systems; and other scientific fields like astronomy and Earth sciences are all dependent on space science and technologies (South Africa, 2020; United Nations Office for Outer Space Affairs, 2019).

Given the above, remote sensing may be regarded as the collection of data at a distance, mainly through a satellite or an aircraft as opposed to on-site sensing. This occurs when a sensor carried by a satellite, or an aircraft detects electromagnetic radiation from the earth and its natural resources. This electromagnetic radiation could be reflected from an external source of energy such as the sun or another source of energy carried by the same satellite or aircraft. Remote sensing could be passive or active. Thereafter, the detected signal is channelled through various algorithms to reach parameters of interest. Parameters of interest that can be derived through remote sensing include several factors, such as humidity, sea or land temperature, altitude, cloud coverage and

rainfall, air pollutants, livestock density, vegetation indices, population density, soil coverage and other environmental factors. Remote sensing is one of the important methods used for the quick and direct acquisition of information on the Earth's surface (Ashraf, Maah & Yussof, 2011; Liu, 2015; Zhu, Suomalainen, Liu, Hyyppä, Kaartinen & Haggren, 2017).

Another form of space technology is satellite navigation systems, which provide autonomous global geo-spatial positioning. Satellite navigation systems allow any user on or near the Earth's surface to determine his or her position with accuracy. Examples of global navigation systems are the USA-based Global Positioning System (GPS); the Europe-based Galileo; and the Chinese-based BeiDou. Other systems are the Russian Global Orbiting Navigation Satellite System (GLONASS) and the Japanese QZSS (Djaja, Putera, Rohman, Sondang, Naditho & Suyanti, 2017). Satellite communication is another system of space technology. Satellite communication refers to the ability of information to be transmitted from one area to the other through communication satellite orbiting around the Earth. This form of communication often occurs via mobile satellite phones, which is different from the common cellular phone communication using earth-based towers that form a cellular network. Satellite communication systems provide many benefits, such as wide area coverage; reliable delivery of data; and robustness (OECD, 1995; Labrador, 2020).

The two main components of satellite communication are the ground segment and the space segment. The ground segment consists of fixed or mobile transmission systems, reception, and auxiliary equipment, while the space segment consists of the satellite itself. Satellite communication often consists of the transmission of signals from an earth-based station to a space-based satellite. Thereafter, the satellite receives and amplifies signals received from the Earth and retransmits them back to Earth. Users on the ground can receive satellite communication through direct-to-home satellite equipment; satellite telephones; hand-held communication devices; or mobile reception equipment installed in an aircraft (Labrador, 2020; NASA, 2012). Other satellites, such the ones used for remote sensing, navigation, and global positioning systems, are placed in low earth orbits and can cover the entire Earth's surface by completing a single orbit around the Earth each 100 minutes.

The socio-economic benefits of space technology are numerous – it makes it easier for people to communicate anywhere in the world; and it further allows for the accurate observation of any spot on earth surface. Moreover, space technology can facilitate the location of any fixed or moving object anywhere on the globe's surface (African Union, 2017; South African Council of Space Affairs, 2020). Earth observation, on the other hand, refers to the process of gathering information about the Earth's physical, biological, and chemical systems. It involves the continuous monitoring and assessment of the status of the natural or artificial environment and the related changes. With the expansion of remote sensing satellites, earth observation has become more sophisticated and more technologically inclined (European Union, 2016; OECD, 2017; Tatem, Goetz & Hay, 2008).

Earth observation involves the utilisation of various instruments including floating buoys, which are used to monitor ocean currents, sea temperatures, and the sea's salinity. Other instruments are land-based stations, which are used to conduct a variety of observation tasks, such as monitoring the quality of air and rainwater trends; and sonar and radar systems, which could be used for estimating bird and fish populations. GPS stations, drones and other environmental satellites are also used for the observation of earth from space. Earth observation is important for several reasons. It is important in assisting nations to introduce or formulate environmental policies and to measure the impact of such policies. It also allows for the measurement and mapping of changes in forestry resources, and it can monitor a country's forests and the applicable environmental interactions (European Union, 2016; OECD, 2017; Tatem, Goetz & Hay, 2008).

3.2.2 Civilian and societal applications of space technologies

Space technologies continue to be of value to societies in different ways. They also contribute positively to sustainable development. For example, weather and communication satellites can maintain a constant view of the Earth's surface by completing a single orbit around the Earth each 24 hours. These satellites can gather important information regarding the nature and conditions of the atmosphere, sea and land. They can observe and report on finer issues about the terrain, the weather, and the environment. Environmental aspects, such as the temperature of objects and their

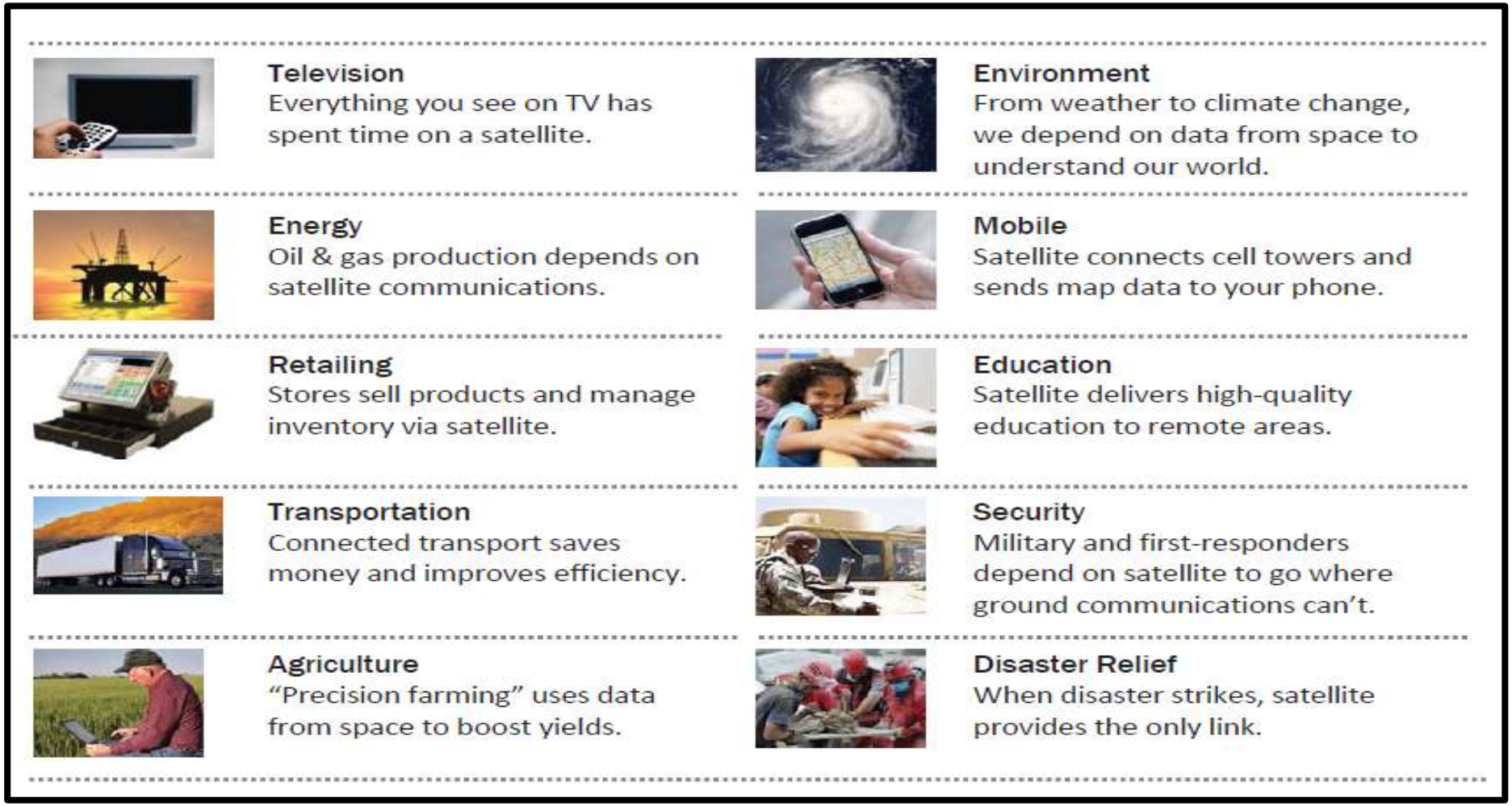
composition; the direction and speed of the wind; and environmental conditions, such as land erosion, fires, and pollution, can be detected through space technology. Thus, space technology can easily monitor larger areas of the Earth to detect aspects such as the spread of pollution and environmental degradation (African Union, 2017; South African Council of Space Affairs, 2020). The following discussion highlights some of the sectors benefiting from the application of various space technologies to achieve societal objectives. These sectors include communication, agriculture, and land, maritime, aviation, road transport and logistics, education, health, and water care and management. **Figure 3.1** as per the Space and Satellite Professionals Internationals (SSPI) (2020) indicates the comprehensive application of space technologies, including in the safety and security sector.

3.2.2.1 Communication sector

Communications satellites enable global telecommunications systems by relaying signals carrying voice, video, and data between two or more locations. While it may still be possible to establish global communications networks through Earth-based communication systems, space-based technologies reduce infrastructure requirements and offer more cost-effective service delivery options. Space-based communication systems have a positive impact on almost every aspect of the daily lives of humans. For example, satellite technologies have changed the way banking and financial activities are conducted by increasing access to affordable financial products to customers in developing countries and allowing payments and transactions to be made from remote areas across the globe.

Space technology has changed daily communications by allowing long-distance domestic and international phone calls; video communication; and the streaming of various media formats; and it has further enabled satellite television and radio. Communication satellites provide access to the Internet. Thus, the global coverage of space-based technologies, such as satellites, offers unique and practical solutions that can help the world overcome many of its challenges (Marshall, 2017; Greenblatt & Anzaldua, 2019).

Figure 3.1: Various uses of space-based technologies



Source: Space and Satellite Professionals Internationals (2020)

3.2.2.2 Agriculture and land management sectors

Space technologies have also been beneficial in areas of agriculture, for example, they can assist planners in managing scarce water resources in times of drought. Moreover, they can be beneficial when predictions of breeding locust swarms can be detected through satellite images. This implies that potential agricultural disasters can be averted through space technology. In other areas, space technologies are of great assistance to mappers in that with satellite imagery maps can be produced much faster than they could be through ground surveys. This could be of assistance to town planners, where the spread of populations can be monitored and identified with relative ease. Moreover, in the military context, for instance, space technologies are used in peacekeeping missions to study the terrain and offer troops a glimpse of the unknown terrain (African Union, 2017; South African Council of Space Affairs, 2020).

3.2.2.3 Maritime industry

Space technologies, such as satellite navigation systems, use satellites as points of reference to calculate positions accurately to within a few meters. These technologies are built into vehicles, ships, aircraft, mobile computers, and construction equipment to either assist with navigation or help to track these assets. Space technology has been employed in the maritime sector for the daily long-range monitoring of the movement of ships and illegal shipping activities; as well as to monitor oil spills in the ocean. Space technologies provide maritime authorities with accurate information on the location of ships and their cargo. They also provide early precautionary information for risk mitigation and emergency response during maritime incidents (Lourenco, 2014; Russell, 2017; South Africa, 2020; Tarr & Marshall, 2017).

Space technologies also provide up-to-date information for the efficient management of port logistics and for effective maritime law enforcement. To achieve all this, maritime authorities and search and rescue teams across the world require detailed, reliable, and timely knowledge about what is happening at sea. This is a daunting task, which can be achieved easily using various space technologies. Space technologies

provide information of critical importance for nations in protecting and extracting economic value from each country's Economic Exclusion Zone (EEZ); guarding national maritime interests; and facilitating better understanding of various climate change models. It can also be used in the maritime environment to support shipping and maritime safety. In addition, space technology is used in hydrographic surveying and has been extensively utilised to map the colour of the ocean; currents; wind direction; and temperature (United Nations, 2005; South Africa, 2020; African Union, 2017; The European Space Agency, 2020).

3.2.2.4 Aviation industry

Navigation and positioning are critical factors for international air traffic control and management. Therefore, the ability to provide accurate global navigation coverage is of paramount importance in support of flight operations and maximising air traffic safety. Space technology has become an enabler of efficient flight operations by eliminating airspace congestion; enabling precise navigation, thus eliminating costly flight delays, diversions, or cancellations of flights; and reducing fuel consumption due to precise navigation. Another indirect contribution of space technology to the aviation environment is in decreasing the environmental impact of travel through precise and efficient navigation. Space technology is also used in the aviation industry for communication. For example, pilots are required to exchange messages through various communication formats with engineers, flight planners, air-traffic controllers, and airline customer care workers on the ground. They also need up-to-date weather reports and wind forecasts. This is achieved through space technology-enabled communication systems. Moreover, there is the emergence of on-board Wi-Fi, which often relies on connections between earth-orbiting satellites and antennas installed on aircrafts. Satellite-enabled telephones are other space technology related devices used on board a flight to enable communication between the flight crew and ground stations (African Union, 2017; South Africa, 2020; Vanhoenacker, 2019).

3.2.2.5 Road transportation and logistics industries

Other applications of space technologies are in the road transportation and logistics industries. The emergence of smart transportation solutions, which are focused on

integrating several modern technologies, such as vehicle navigation, container management and traffic control signals, has meant that for transportation and logistics industries to be economically profitable and environmentally friendly, they need to capitalise on the emergence of smart transportation technologies (McGreal, 2017). Similar to the maritime and aviation environments, these technologies are important in several areas, such as providing drivers with directions; rerouting traffic during adverse weather conditions or disasters; and allowing for the adjustment of speed limits based on practical considerations. These are all important factors to improve safety and efficiency in all areas of transport and logistics. Achieving these essential conditions of road transportation and logistics requires the transmission and exchange of huge amounts of data between various role players (British Interplanetary Society, 2018).

Thus, space technology such as satellite communication technology makes it easier and more reliable to transmit continuous and far-reaching data. Road transportation hubs can benefit from these technologies by exchanging information on issues like temperature sensors, weather conditions, routes and diversions, speed sensors, and congestions. The use of satellites also assists in alleviating road congestion. Where there is an accident or heavy traffic on the roads, space technologies are able to detect this and communicate with transport hubs and, in turn, transport hubs will communicate such information to vehicles on the route and advise them to divert to alternative routes. On the other hand, should there be an accident, automatic notifications could be sent to the hub so that emergency services could be dispatched, depending on the severity of the accident. Replacement vehicles could also be dispatched using this method to ensure the continued provision of services (Aapaoja, Praks, Hautala, Kostiainen, Kinnunen & Hoyhtya, 2017).

In recent times, we have seen the emergence of the concept of drone deliveries in support of e-commerce, especially in China. This has been more critical than ever before due to the COVID-19 pandemic. The use of space technologies, such as drones for deliveries, is now regarded as an important aspect in dealing with the trade restrictions imposed by COVID-19. They can be used to make various deliveries, such as food and medical supplies, to quarantined and isolated areas. Similar technologies are being explored for use in South Africa through the introduction of smart delivery drones, which have been approved by the South African Civil Aviation Authority

(SACAA). This technology will also be used to inspect railway lines, power lines, and large-scale farms (Caboz, 2020; McNabb, 2020; Silver, 2020).

3.2.2.6 Education sector

Remote and rural communities often find it difficult to access education. However, space-based technologies are assisting in bridging this gap. Space technologies, such as satellite communications technologies, enable remote and rural communities to have access to education. Through web-based platforms, videoconferencing, and Voice over Internet Protocol (VoIP), schools can create virtual classrooms where teachers and students are able to interact despite being in different physical locations, which in many instances could be great distances apart. Students are also able to access web-based learning materials in the comfort of their own homes and can interact with teachers through electronic mails, video recordings, or message boards (African Union, 2017; Di Pippo, 2020; UNOOSA, 2007).

These technologies have gained popularity and have enabled various educational institutions to offer a variety of distance education programmes, such as degrees and doctoral programmes. Thus, space technology allows teaching and learning to happen anywhere by bringing people together, and encouraging exploration, collaboration, and discussions. It also allows for flexibility and networking by bringing together both formal and informal learning activities in a unified environment, which recognises the notion that learning can happen anytime and anywhere. These technologies also allow for the augmentation of in-class teaching and learning activities through interactive systems, and further allows for the online sharing of content with peers (Warger & Dobbin, 2009; Elkington & Bligh, 2019).

The need for online learning has become much more popular and in demand amid the recent outbreak of the COVID-19 pandemic. With the closure of many educational institutions and the need to salvage the academic year, space-based technologies have become more important than ever before in the education sector. These technologies' teaching is undertaken remotely and on digital platforms. Space-based technologies allow for e-learning to take place through various platforms, including language

applications, video conferencing or online learning software (World Bank, 2020; Allen, 2020; Li & Lalani, 2020).

3.2.2.7 Health sector

The health industry is also a beneficiary of space technology. The global health fraternity has capitalised on the benefits of space technology by being innovative. For example, the health fraternity uses remote sensing technology to detect environmental changes that have the potential to affect the health of local populations. It also makes use of satellite communication for medical related missions and to manage natural disasters. Another use of space technology in the health fraternity includes advancing the medical body of knowledge through space medicine programmes. Space technology is also used to tap into the benefits of localisation by using global navigation satellite systems (Dietrich, Dekova, Davy, Fahrni & Geissbuhler, 2018).

Moreover, telemedicine has become an innovative solution to the provision of medical assistance to remote and inaccessible areas. The inaccessibility could be ascribed to geographical distance or physical barriers, such as mountains or deserts. In other instances, it could be linked to insufficient time available to transfer a patient to a health facility. Telemedicine is also used when providing medical care to astronauts in need of medical assistance in space stations. In these instances, the medical fraternity must deal with severe restrictions related to being unable to quickly transfer or physically attend to the patient; or to provide limited medical resources and the requisite medical expertise to the patient. Thus, telemedicine offers possible solutions in these scenarios. Telemedicine offers the opportunity of connecting two parties, for instance a specialist medical practitioner and a patient who are a distance apart through a third party, such as a general practitioner, who might lack the skills to provide the necessary medical intervention. Telemedicine can be offered through a satellite or cellular network (Algaet, Noh, Shibghatulla, Milad & Mustapha, 2014; Bisu, Gallant, Sun, Brigham & Purvis, 2018; Ross, 2001; Latifi, 2008).

Space-based technologies also allow for the achievement of what is termed health-on-the-go where mobile medical units can provide treatment or transmit health related information, including texts, images, or laboratory exams, through satellite

communication (Mupela, Mustarde & Jones, 2011). Other benefits of space technology in the medical fraternity are in the field of medical tele-education. As in the provisioning of general education, as discussed earlier, medical tele-education refers to the practice of providing new or continuing medical education through distance learning (Bhaskaranarayan, Satyamurthy & Remilla, 2009). Space technologies, such as drones, are also an important feature of telemedicine as they can perform the role of patient and medicine transportation in inaccessible, impassable, or hostile terrains. They can further be used to transport medical or microbiological samples from one point to another. In the military, drones have also been used to remove injured soldiers from the battleground (Amukele, Sokoll, Pepper, Howard & Street, 2015; Beebe & Gilbert, 2010; Mendelow, Muir, Boshielo & Robertson, 2007).

3.2.2.8 Water care and management sector

Furthermore, space technology can be used to study water quality. The colour of water can provide a hint of what is in it. For example, water could be blue, green or dark brown. All these colours could be an indication of the presence or absence of something in the water. Concerns about water quality could arise from factors such as oil spillages, the inflow of agricultural drainage water, and the direct discharge of industrial and domestic wastewater into a lake or river system (Mohamed, 2015; Andres, Boateng, Borja-Vega & Thomas, 2018). Therefore, a proper response to water quality issues and the design of adequate water management systems are mainly dependent on access to accurate and reliable information on the occurrence and distribution of water quality parameters.

Although role-players in the water quality and treatment fraternity measure drainage channels leading to a river or lake to assess the quality of the water, such methods are insufficient and expensive. These measures are also unable to detect the spatial and temporal variability of water quality parameters in highly vibrant river or lake ecosystems (Su, Yacob, Wen, Roerink, et al., 2003). Considering these challenges, space technologies, such as imaging satellites orbiting the Earth, can detect these colour variations. Remote sensing techniques, together with UAVs are also able to measure water qualities issues and aspects such as water levels (Andres et al., 2018;

Koparan, Koc, Privette & Sawyer, 2018; Swain & Sahoo, 2017; Ligi, Kutser, Kallion, et al., 2016).

The discussion above sought to identify some of the key applications and benefits of various space technologies. Although this list only provides a fraction of what space technologies entail and what they are capable of discharging, there is enough evidence to suggest that space technology is an important feature of today's world. This is becoming more important as the world gears up for the Fourth Industrial Revolution (4IR). The next section of this research will examine how developed and developing countries are embracing space technology, including South Africa.

3.3 Space technology in developed countries

The international space technology arena is dominated by the USA, Europe, Russia, and Japan, as they were the first to explore the planet and human spaceflight capabilities. The USA undoubtedly dominates the world space science and technology arena. It has made significant investments in both civilian and military space activities, exceeding all the other countries combined. However, several other countries are also entering the space arena. These countries, India and China, have their own human spaceflight and exploration programmes. All these countries also have the capability to develop, build, launch and operate a variety of space systems (Aerospace, 2015; Jennings, 2017). This next section will examine the space technology programmes of three developed countries, namely the USA, China, and Russia.

3.3.1 United States of America

The USA is the leading country among the top ten countries in space science and technology. It accounts for some 30% of all operational spacecraft in orbit around Earth. Together with NASA, the USA has led many space exploration initiatives, such as the Apollo moon-landing mission; the launch of the International Space Station (ISS); and the Mars Exploration Rover mission. The USA launched its first satellite, Explorer I, into space in 1958, following the launch of a satellite, Sputnik I, by the Soviet Union in 1957. The USA operates a large fleet of civilian and military space technologies, including communications, navigation, surveillance satellites, electronic

intelligence, and missile detection (Markovich, Chatzky & Siripurapu, 2020; Williams, 2019; Wohrer, 2017).

The USA ventured into outer space in the 1940s, with expanded research in rockets and atmospheric sciences. The rationale behind the heightened interest by the USA in space science and technology was to ensure that it was not outpaced by the Soviet Union in the post-World War II period. Thus, the launch of Sputnik by Russia in 1957 convinced the USA policy makers that the country was behind its Cold War rivals, Russia, on space technology matters. Thus, the USA made major investments in scientific research and education to meet this policy challenge. These investments drove the USA to victory in the space science and technology industry (Markovich, Chatzky & Siripurapu, 2020; Williams, 2019; Wohrer, 2017).

The USA considers space technology as a strategic asset for both civilian and military applications. Therefore, independent access to such technologies has become an inherent USA government policy. Although each launch of a satellite might not necessarily be open for competition, open access has encouraged innovation and competition among various parties of interest (Swarts, 2017). The USA has historically embraced the role that the space science and technology industry has played and continues to play in enabling technological and societal changes and how these changes have consequently changed the perception of space research and exploration. It also acknowledged that space technologies are an essential and practical part of our daily lives (Gibbons, 1995).

Another remarkable achievement by the USA in the field of space technology was the development of the GPS, which was originally developed by the USA military to enhance navigation and for weapon targeting purposes. The GPS has transformed many industries across the globe in many ways. Instead of using paper-based maps, travel atlases, or stopping to ask for directions, drivers are now able to obtain directions accurately from GPS devices. GPS has also enabled services such as e-hailing services, package tracking, goods delivery services, and self-driving cars. Other GPS uses include fitness tracking and providing locations during emergencies. The USA also recognised that the ability to observe global military activities from outer space would provide a greater military advantage and would further serve as a national security

asset. As such, the USA embarked on a process of building complex observation and electronic-interception intelligence satellites, which was based on the success of its photo reconnaissance satellites in the 1960s (Britannica, 2020; Matignon, 2020).

3.3.2 China

China officially launched its space programme in 1956, a year before the Soviet Union was successful in launching its first satellite, through the establishment of the Fifth Research Academy of the Department of Defence. Qian Xuesen, known as the father of the Chinese missile and space programme, was appointed as the director responsible for implementing the Chinese space programme. One of his main objectives was to develop intercontinental ballistic missile rocket technology (Chen, 1991; Harvey, 2004). However, it is argued that Xuesen was not the main and sole contributor to the design of any Chinese missile or satellite programme. In 1993, China's space programme was reformed with the establishment of China's National Space Administration (CNSA), which is responsible for developing and planning China's space activities (Klinger, 2020; Kulacki & Lewis, 2009).

Like the USA, China felt the pressure from the Soviet Union and did not want to be left behind by its economic, military and technological rival on such an important technological development. The feeling was that China should also launch a satellite. Therefore, the same political, military and prestige reflections, which shaped the USA and the Soviet Union's space programmes, also influenced China's interest in pursuing a space programme. In 1970, China launched its first satellite. This was over 30 years since the Soviet Union launched its first satellite. Due to its limited knowledge of missile technology, China sought the assistance of the Soviet Union on technical and material matters (Kulacki & Lewis, 2009; Stroikos, 2016).

It could have taken China much longer to develop its own space programme and to launch its first satellite successfully if it were not for the knowledge Qian Xuesen gained whilst in the USA studying and practicing aeronautical engineering. China took long to catch up with the space programmes of the USA and the Soviet Union due to limited cooperation between China and other countries with advanced space programmes. However, since the 1970s, China has made significant progress and has

managed to achieve many significant space programme milestones and to close the gap between itself and the likes of Russia and the USA (Harvey, 2004; Harvey 2013).

In the 1980s, China continued with its ambition and embarked in a process of developing communication satellites. This need emerged because of China's vast geographical area and the need to provide efficient communication. Communication satellites were most suitable for the task, as they could save time and funds and eliminate costly and complex systems of relaying television transmission signals and fixed landlines for telephone communication. It attempted to launch its communication satellite in 1984 but failed due to the failure of the rocket in the third stage. However, the second attempt was successful, and the Dong Fang Wong series of satellites were launched, which provided and expanded television and communication networks across the whole of China. China's quest continued with the launch of navigation satellites in 2000 (Harvey, 2004; Harvey 2013).

With China catching up with the USA and Russia on space technology programmes, it had the goal to establish itself as a leading nation in civil and military space science and technology. China has dedicated adequate financial resources and high-level attention to catch up and ultimately outdo spacefaring countries like the USA and Russia in space science and technology, military power, and diplomacy. One of its plans was to launch its first long-term space station by 2020. The massive interest and investment in space technology can be linked to the fact that China views space as critical to its economic and security prospects. Massive investments and resources have been dedicated to exploring the economic and security benefits of outer space. This includes exploring the potential for space power generation, resource extraction, and space-based manufacturing (Qiu, 2017; Jones, 2020; US-China Economic and Security Review Congress, 2019).

3.3.3 Russia

Little was known about Russia's space efforts, which in most instances occurred in secrecy, although their space launches were public. It was only in recent decades when a detailed history of Russia's space exploration was narrated through detailed books and verbal communication by former cosmonauts. Russia inherited its space

programme from the Soviet Union, which had a vast network of space industry enterprises. It also had a sustained human spaceflight programme and a long and great tradition of technological innovations and impressive space technology initiatives. Some of the first space exploration events achieved by the Soviet Union were the first man in space in 1961; the first daylong flight, also in 1961; the first woman in space in 1963; the first multi-crew spaceflight in 1964; and the first spacewalk in 1965. Other space initiatives by the Soviet Union were the first space station mission in 1971; the first docking with and repair of a dead-in-space station, which was carried out in 1985; the first spaceflight between two space stations, conducted in 1986; and the first permanently crewed space station, Mir, between 1986 and 2001 (Petersen, 2019).

The Russian-Soviet space programme gained importance after the World War II when the Soviet Union and the US governments relied significantly on technologies developed during the War and on the expertise of German rocket scientists to venture into outer space. With the assistance of German rocket scientists, Russia was able to launch an artificial satellite, Sputnik I, in 1957. After the successful launch of Sputnik 1, the Russian government deemed it necessary to accelerate plans for crewed missions. Resulting from these renewed efforts, Russia saw the launch of the first space mission, Vostok I, in 1961, followed by yet another space mission, Vostok 6, which saw the first woman to orbit Earth 48 times (West, 2001; Petersen, 2019; Williams, 2019).

The collapse of the Soviet Union in 1991 brought significant challenges for Russia’s space programme. The economic challenges of that period contributed to Russia rethinking its objectives of a Russian human spaceflight programme. Russia turned to private industries to keep its space programmes afloat. Some of the initiatives involving the private sector included space tourism and the launch of commercial satellites. After 15 years of turbulence, Russia was able to resurrect its space programme through the leadership of the State Corporation for Space Activities (Roscosmos). In 2005, Russia began to experience considerable economic growth and, as a result, Roscosmos received increased funding for its outer space programmes. These developments led to a revived interest and improved Russia's commitment to the ISS in deploying research satellites and crewed missions to outer space. Because of the renewed funding and after 22 years of development, Roscosmos was able to launch the Angara rocket. The initial

test launches took place between July and December 2014. The Angara rocket family was developed to replace older rockets built by the former Soviet Union. Although there is still competition between Russia and the USA on space programmes, there is also greater cooperation between NASA and Roscosmos through the ISS. To advance its ambitions in space science and technology, in 2016, the Russian government approved the country's 10-year space programme, referred to as the Federal Space Program 2016-2025, worth $20.5 billion (Berg & Howell, 2018; Clark, 2020; Williams, 2019).

Russia continues to play a significant role in the development of space technologies. In May 2019, it launched a GLONASS-M 758 navigation satellite into orbit, which became operational in June of the same year. This satellite replaced the GLONASS-M 723. Moreover, the first Russian global positioning satellite became operational in 2010, which was designed to compete with the USA's GPS. In addition, regarding Earth observation and remote sensing technologies, Russia continues to offer diverse and comprehensive satellites. Earth observation and remote sensing technologies are of great importance to Russia, but significant budgetary constraints have prevented it from realising their full potential. However, with Russia's long and illustrious history of remote sensing, plans are underway to launch $147 million worth of earth observation satellites by the end of 2025. The plan would be to increase the number of national remote sensing satellites from eight in 2017 to 20 by 2025. Russia also has an ambitious plan to deploy 640 satellites into space through the SPHERE project. The main objective of this project is to address Russia's communication and internet access challenges, as well as enhance navigation, and geo-positioning and remote sensing. The deployment of these technologies will be in three phases, namely in 2022, 2024 and 2028 (Business Standard, 2018; Henry, 2018; Chaudhary, 2019).

3.4 Space technology in developing countries

The civilian use of space technology in areas such as communication, remote sensing, and navigation could provide several crucial benefits, as earlier discussed, in agriculture, education, medicine, and transportation. This is even more relevant in developing countries. Although there is a great potential for the development and application of such technologies to assist in solving a magnitude of problems faced by

developing countries, the lack of expertise, funding and equipment in developing countries hampers the ability of such countries to employ space technologies to fulfil their socioeconomic objectives (Akinyemi, 2020; Leloglu & Kocaoglan, 2008).

The emergence of new satellite technology such as microsats and nanosats, nevertheless, makes it easy for developing countries to develop their space capabilities and to participate in global space projects. Many countries that were previously not space capable are now actively pursuing domestic space programmes. Several developing countries have been able to launch small satellites. These satellites make it possible for even a country with a small space-related research budget to be able to participate in the development, launching and operation of satellites. These satellites are also an ideal platform for research and development, especially in the fields of software development, engineering, and the management of sophisticated technological products. Thus, research in space technology could contribute significantly to the development of scientific knowledge for many people and create new opportunities for greater innovation and infrastructure development (Othman, 2003; Doncaster, Shulman, Bradford, & Olds, 2016; Wood & Stober, 2018).

This section of the research will look at the space technology programmes of three developing countries – India, Brazil, and South Africa. These three countries, including China and Russia as discussed earlier, are part of the bloc of emerging economies of Brazil, Russia, India, China, and South Africa (BRICS), which was formed in 2010.

3.4.1 India

India commenced with its space programme in 1961 with the establishment of the Indian National Committee for Space Research (INCSR). In the following year, it launched its first sounding rocket from Thumba Equatorial Rocket Launching Station in Kerala. This station was developed for space projects, including analysing upper atmospheric regions and conducting space-related research. The launch of the sounding rockets marked the official beginning of the Indian space programme. Between 1965 and 1969, India engaged in several space science and technology related activities, which included the establishment of the Space Science Technology Centre (SSTC) in

1965, followed by the setting up of India's Satellite Telecommunication Earth Station (STES) in 1967 (Sankar, 2007; Goyal, 2019; Shah, 2019; Mann, 2019).

Another satellite station, the Experiential Satellite Communication Earth Station was set up in in 1968, followed by the formation of the Indian Space Research Organisation (ISRO) in 1969. Further developments emerged in the 1970s with the formation of a number of institutions and space programmes. In 1971, the Satish Dhawan Space Centre was formed in Sriharikota, followed by the establishment of the Department of Space. A major milestone in space science was achieved in 1975 when the first Indian satellite was launched into space. Although the satellite was launched from a Russian facility, it was wholly designed in India. India's space ambitions continued to grow with further satellite communication projects. Its first experimental remote sensing satellite, built in India, was launched in 1979 mainly for hydrology, forestry and oceanography studies (Rao, 2014; Goyal, 2019; Mann, 2019; Shah, 2019).

The 1980s also showed significant advancements in India's space programme, when the communication satellite, Insat-1, and the Indian Remote Sensing Satellite, IRA-1A, were launched in 1982 and 1988 respectively. Further space projects followed in the 1990s and 2000s, when India launched more satellites such as the remote sensing satellite, IRS-1B, in 1991 and the radar imaging satellite, Risat-2, in 2009. The years 2011 to 2019 saw the launching of more satellites, including a regional navigation satellite in 2013; the latest communication satellite, GSAT-15, in 2015; the regional navigation satellites in 2016; and the communication satellite, GSAT-17, in 2017. The GSAT-11, which is India's heaviest communication satellite, was successfully launched in 2018, followed by the launch of two microsats in 2019 (Goyal, 2019; Mann, 2019; Rao, 2014; Shah, 2019).

India's motivation to embark on space projects was mainly in pursuance of the social and economic upliftment of its citizens. After gaining its independence, scientific developments were another way of shaping India's destiny. It should be highlighted that India's space programme differs significantly from the USA and Russia's programmes, which were driven mainly by the quest to develop space technologies for military power, unlike India's desire to use space science and technology to pursue socioeconomic benefits and to further its political ambitions. However, there are

growing calls from senior government officials and policymakers in India advocating for the militarisation and weaponisation of India's space programme to enhance its military space capabilities. The ability of the ISRO to continually develop and launch space technologies earned it the recognition of being one of the most respected scientific institutions in India (Shah, 2019). To show its increased and continued commitment to its space programme, India Department of Space's budget for 2020-2021 saw an increase of 7.5 percent from the preceding budget. It is also an increase of over 45 percent from the 2015-2016 budget (Narasimhan, 2020; Prasad, 2020).

3.4.2 Brazil

Brazil is the strongest and most advanced country among the Latin American countries in space science and technology capabilities. Brazil is a large country possessing many fragile natural resources, such as the coastlines and the rainforest. Most of its regions are remote and have a low population density. Moreover, most of its regions have experienced long periods of drought; this situation was compounded by serious social problems, including poverty. All these conditions motivated Brazil to pursue space technology to manage the unique challenges it faced. Its weak road and energy infrastructure could not support Brazil's industrial development. This meant that Brazil had to rely on space science and technology to provide it with a better understanding and knowledge of all its various regions. Consequently, this could help Brazil in planning and controlling some of its social and economic activities, such as agricultural activities, deforestation, and weather forecasting. In addition, the use of space technologies, such as satellites, could provide Brazil with an improved and more efficient telecommunications network (Fonseca & Bainum, 2006; Krug, 1998).

Other compelling factors were its wide and sparsely populated territory, which could provide an excellent platform to develop a space-launching base. Brazil began pursuing its space science and technology programme in 1961 through the establishment of the National Institute of Space Research, which in 1971 became the National Institute for Space Research (INPE) with its focus being scientific research and facilitating a better understanding of space technology. This required Brazil to invest more on infrastructure in order to support, integrate and test its spacecraft. It also needed to invest more on developing its human resources to enable it to carry on its work in outer

space; and further develop software systems to enable it to simulate, forecast and control orbit and altitude among other space challenges (Krug, 1998; Fonseca & Bainum, 2006).

Brazil pursued space capabilities in communication, remote sensing, and navigation to meet its environmental and developmental challenges. The Brazil Defence Strategy also highlights the importance of space technology to meet its national security objectives as part of its research and development. Moreover, Brazil developed sounding rockets in its Sonda series, which were launched between 1965 and 1990. These rockets had a maximum flight altitude of between 56 and 800 kilometres and weighed between 100 and 200 kilograms (Matignon, 2019). After this, Brazil launched the SCD-1 and SCD-2 satellites in 1993 and 1998 respectively through what was termed the Complete Brazilian Space Mission (MECB). Moreover, in 1988 Brazil and China signed an agreement of cooperation for the development of the Chinese-Brazilian Earth Resource Satellite (CBERS) for generating images of the Earth. Through this collaboration, a satellite was launched in 1999, followed by the second one in 2003 (Dewes, Concalez, Passaro & Padula, 2010; Forman, Sabathier, Faith & Bander, 2009).

In the initial phase, China contributed 70 percent of the funds and Brazil provided 30 percent towards the CBERS. Later, the two countries made equal contributions of 50 percent each in the project. With the creation of the Brazilian Space Agency (AEB) in 1994, Brazil sought to grow its capability in space science and technology and further sought to identify new opportunities for new space projects, which could bring about socioeconomic benefits, especially in the area of satellite data analysis. To realise this, the Ministry of Science, Technology, Innovations and Communications entered into an agreement with Visiona, which was a joint venture between the state-owned telecommunication company, Telecomunicaçoes Brasileiras, and a space technology company, Embraer Defense and Security. Prior to this collaboration, Brazil did not have its own satellite but depended on satellites operated by foreign countries for its space-related activities. However, this collaboration paved the way for the delivery of the Brazil Geostationary Defense and Strategic Communication Satellite (SGDC) in May 2017 for the purpose of providing technical services and enabling transfers of satellite technologies and sensors. This satellite provides strategic communication for

the Brazilian Ministry of Defence and further provided broadband communication for the Ministry of Communication. With Brazil preparing for the launch of more satellites and developing its own improved launching capability, its intention is not only limited to that, but it further seeks to build satellites for earth observation and enhanced communication capacity. These efforts clearly reflect Brazil's broader geopolitical ambitions of advancing its role in outer space, both on the regional and international stage (Da Cas, Veras, Shynakarenko & Leonardi, 2019; Thales, 2019; Sly, 2020).

3.4.3 South Africa

South Africa's active participation in space science and technology began in the 1950s, mainly with amateur rocket launching activities. In the late 1980s, South Africa commenced with a military programme to develop a launcher and a reconnaissance satellite. To support this initiative, a satellite integration facility and a launch facility were established in the Western Cape. However, this was discontinued in 1994 and the facilities were taken over by the Department of Communications to be used for a variety of research and training applications. It was through the 1993 Space Affairs Act that the South African Council for Space Affairs (SACSA) was established. SACSA is responsible for administering all legal aspects related to South Africa's space activities and further maintains a register of all objects launched into outer space by South Africa (Ghadaki, 2010; Gottschalk, 2010; Martinez, 2008). It may, however, be argued that the development of space activities in South Africa was not solely because of the establishment of SACSA. Work completed by various academics in satellite construction and the pressure experienced by the then apartheid South African government due to sanctions imposed on the country led to the development of its independent launching capabilities.

Renewed and expanded space projects and a new science policy took effect in 1994 after the election of a democratic government. The demise of apartheid opened South Africa to new opportunities and afforded it the opportunity to participate in more space science activities than during apartheid. The policies of a pre-democratic South Africa were mainly defensive and driven by the requirements of the apartheid regime, fueled by its isolation from the international scientific community, as opposed to the need to

participate in the global space science and technology setting (Whitelock, 2007; Martinez, 2008).

In 1995, the South African departments responsible for science and technology, and trade and industry, drafted the first post-apartheid space policy and strategy to provide guidelines on managing and controlling space science-related affairs in South Africa. Apart from this, the new democratic government had a duty to alleviate poverty and overcome many inequalities caused by the apartheid regime. This required not only a change in social policies, but strong policies in science and technology, and investments in science infrastructure that would contribute to the reconstruction of the country (Whitelock, 2007; Martinez, 2008).

In 1999, through the University of Stellenbosch and a working collaboration with NASA, South Africa launched its first Earth observation satellite, Sunsat. A second satellite, Sumbandila, was developed and launched in 2009 to display South Africa's growth in Earth observation space activities. Sumbandila was launched through a collaboration with the Russian space agency (RKA). Sunsat and Sumbandila are the first microsats to be completely constructed on the African continent and they demonstrate South Africa's regional hi-tech industrial capabilities. In 2011, South Africa established the South African National Space Agency (SANSA), with one of its major objectives being the promotion of cooperation between South Africa and the international community on space-related matters and to fast track the role of South Africa in international space activities. It is also responsible for implementing South Africa's space programme and advising the Minister of Science and Technology on space-related matters; and to collect, integrate and distribute data derived from space activities (Brand South Africa, 2010; Gottschalk, 2011; Ngcofe & Gottschalk, 2013; Space in Africa, 2018).

In 2017, South Africa launched two more nanosatellites containing some of the world's advanced technologies. The nSight1 was designed and manufactured by SCS Space, a group based in Cape Town, and ZA-Aerosat, was designed and manufactured by the University of Stellenbosch's CubeSpace. These two satellites were deployed into low-earth orbit for a period of between 30 and 60 days, as the ISS orbits Earth to record a variety of factors in the Earth's lower thermosphere in the range between 200

kilometres and 380 kilometres in altitude. Data collected from this experiment are of value to current atmospheric models and could be used in environmental studies. By 2020, South Africa had launched eight satellites, which makes it the country in Africa with the second most satellites, after Egypt, which has nine satellites (Anderson, 2017; Klinger, 2020).

The discussion herein highlights the important role space technology plays in achieving the socio-economic objectives of developing countries. This is opposed to the quest of developed countries, such as the US and Russia, which have mainly been driven by the need for military dominance. It further highlights the serious considerations taken by these various countries in developing their space capabilities. Although there are competing priorities in terms of budget spending, all the countries discussed herein continue to acknowledge the importance of investing in space science and technology. They also recognise the importance of collaborations among various government entities, the academic fraternity, and space technology companies –for example, the role played by the University of Stellenbosch in the launching of the first South African satellite, and collaborations between the Brazilian government and a private entity in the development of a communication satellite.

3.5 Space technology and border security

Border control and monitoring is a significant problem for many countries, including South Africa. Many countries find it difficult to detect and intercept intruders and criminal elements who attempt to cross their international borders. These intruders are mainly illegal migrants, human smugglers and traffickers, drug and narcotics smugglers, and other persons who represent a threat to national security and the interests of a country, as is the case with South Africa. One of the main challenges faced by border authorities in controlling and monitoring long stretches of a country's borders is the need for intensive human involvement. This has prompted border security authorities, for example in India, Switzerland, Egypt, and the USA, to seek alternative measures such as the employment of space-based technologies to control and monitor their international borders (Alkhathami, Alazzawi & Elkateeb, 2015; Kumar, 2019; Pedrozo, 2016; *The Economic Times*, 2019; Wilson, 2018).

Several space technologies in the form of video surveillance, radars and satellites are employed by border security entities to control and monitor national territories. Drones form part of these border security technologies and have been identified as a key tool in the surveillance and identification systems implemented globally (Klauser & Pedrozo, 2015). Alternatively, border authorities use wireless sensors and ground-based electro-optical sensors, which are linked to satellites to monitor and control borders (Felemban, 2013; Szechtman, Kress, Lin & Cfir, 2007). Although South Africa has abilities in space science and technology, it lacks the necessary resources and partnerships to employ space technology for the purpose of enhancing border security and minimising cross-border criminal activities (CSIR, 2012; CSIR, 2016; Penderis, 2018; TimesLIVE, 2019b). It should also be noted that in 2017, Parliament's Portfolio Committee on Science and Technology questioned the possibility of using satellites for national border management to curb the crisis of illegal migration caused by porous border control measures; it also asked how else satellites could be used for military purposes in the South African context (PMG, 2017).

If we analyse the border control and monitoring problem generally and in the South African context, as discussed in Chapter two, one might consider a scenario in which an intruder (such as an illegal migrant or a transnational criminal) attempts to cross international borders, which could be physical barriers (such as a fence) or natural barriers (such as a river), as well as imaginary barriers, which denote the beginning and the end of a territory, without detection. The individual illegal immigrant will try to enter and reside in South Africa without the necessary documents and the legal status, which is afforded to foreign nationals who wish to enter and reside in South Africa. On the other hand, it could be a transnational criminal who wants to smuggle or traffic persons into or out of South Africa; or smuggle drugs, precious metals or narcotics into or out of South Africa; as well as a transnational criminal who wants to smuggle stolen motor vehicles or goods across South Africa's borders. In all these instances, the main objective of the illegal migrant or the criminal element would be to avoid detection and ultimately succeed in their attempt to either cross the borders illegally or achieve their criminal intent.

A further analysis would involve a border security official who is tasked with detecting and apprehending intruders at the borderline. This implies that the intruder, as per the

earlier discussion, and the border security official have contradicting interests. Therefore, the intruder will use clandestine methods in his/her attempt to circumvent border processes. This will be done with speed and by hiding in densely populated border areas. On the other hand, the border security official will be moving back and forth constantly along the border area to try to detect an intruder. In some instances, the patrols are random and not target-oriented, thus forming part of a border patroller's routine. What is likely to unfold in these two scenarios discussed above might be easy to predict; one would be an intruder who would succeed in his/her attempt to cross the border illegally. It could also be an intruder who abandons his/her attempt to cross the border illegally due to some deterrence, such as observing a border patrol detail. On the other hand, it could be a border security official who is successful in detecting an intruder who wants to cross the border illegally or execute criminal activities. However, the available literature, as extensively discussed earlier in this research, suggests that it is a huge challenge to detect intruders on South Africa's borders. The available literature, as contained in Chapter two of this study, suggests that random patrol methods and inadequate personnel to cover the entire South African border area makes it extremely difficult for South African border security officials to detect intruders. This situation contributes to mass illegal migrations across South African borders and further fuels a variety of transnational criminal activities.

Conventional systems of border patrol typically consist of border guards and border posts along international roads. At these border posts, the traffic is stopped, and both the vehicles and passengers are inspected to detect any illegal activities. In between the border posts, border guards patrol the border area, using existing routes, at predetermined intervals. This task requires the involvement of extensive human resources, even to patrol small border areas. Foot and vehicle patrols are easy to observe and predict, and intruders will often familiarise themselves with the border guard patrol routine and will capitalise on their periods of absence to cross borders illegally. Although South Africa's borders are manned by the military, extreme weather conditions and the dark of night make it difficult to launch patrols at any time; thus, this provides ample opportunities to intruders (Emad, 2013; Sun et al., 2011).

Therefore, the invention of different technologically based patrol techniques, which could help decrease the need for intensive human involvement and vehicles in border

patrol activities, which have the flexibility to be deployed at any time in any border region, and which have a greater detection capacity, have become necessary. If such a technology is available or if it could be developed, what would it be, and how would it be used in relation to other socio-technical measures of border security. As stated by Wilson (2018), monitoring international borders using human eyes only and by utilising outdated methods is no longer an option, although they are a vital part of a complete border security approach. This author (2018), thus, suggests that existing border security measures ought to be augmented by technological measures. Wilson (2018) adds that countries are resorting to space-based technologies to control and monitor their borders.

Similar sentiments are held by Alkhathami, Alazzawi and Elkateeb (2015) when they state that one of the challenges regarding the protection of large stretches of border area is the need for intensive human involvement for border control and monitoring. These authors (2015) suggest the invention of various technological aids to decrease the need for such intensive human measures. Considering this, a variety of space-based technologies are available on the market or could be developed and integrated to perform a variety of border monitoring activities. These space-based technologies would include satellite technology; aerostats; UAVs; manned aircrafts; sensor-packed UAVs; and remote sensing technology. These technologies are intended to provide border security authorities with situational awareness; optimise border patrol activities; and enable them to react quickly to cross-border criminal activities, such as illegal migration (Klauser & Pedrozo, 2015; Wilson, 2018).

Technological advances in areas such as aerial platforms, image sensors and processing, as well as geo-positioning systems enable near real-time detection and tracking of moving objects on the ground in a more practical and cost-effective manner. These technologies could be ideal for a near real-time monitoring of international border areas, which experience frequent and significant acts of illegal immigration and smuggling. These technologies could assist border security authorities to locate and monitor the movement of people and vehicles across international borders. Low-cost aerial platforms, such as light aircraft or UAVs, could provide repeat imaging over a short period. Other automated specialised image collection and processing techniques

used in border areas assist in detecting changes associated with security threats along a country's border (Coulter, Lippitt, Stow & McCreight, 2011).

3.5.1 Satellite technology

A satellite can be defined as any object, such as a moon, planet or machine, which orbits a planet or star. A machine-based satellite can be defined as a manned or unmanned vehicle that orbits the earth or another planet in a defined path (NASA, 2014). Many man-made satellites orbit Earth for various purposes. Some capture pictures of the planet, which facilitates better research on weather prediction and tracks hurricanes. Other track and monitor other planets (Sivaramaganesh, Ramya, Gowtham, Bharathi & Jeevitha, 2004). Satellites play multiple roles in securing a country's borders. This research emphasises three specific areas of satellite-based technology, which could meet the needs of a country's border security. These satellite technologies are remote sensing, navigation, and communication. Remote sensing satellites could be categorised as remote sensing satellites using optical sensors and satellites using infrared sensors. Other remote sensing satellites are satellites, which use imaging radar techniques, and others are satellites referred to as signal-intelligence (King, 2004). Remote sensing technology could be applied widely in different fields of science and industry. Its usefulness also needs to be assessed for application in land border surveillance (Malinowski, 2010).

The common belief that satellites are only for wealthy countries is slowly diminishing. The costs of developing and launching satellites have dropped significantly in recent years, especially with small satellites like CubeSats and nanosats (Defenceweb, 2018b). Thus, developing countries can take advantage of this development and use satellites for a variety of ground-based activities including border monitoring. Satellite technology offers many benefits for border security and monitoring, to manage military threats and potential acts of terrorism (Malinowski, 2010). One such benefit is visibility through earth observation satellites. In vast border areas, border guards could be stationed kilometres apart. As such, they could depend on a variety of electronic surveillance technologies to detect and track intruders and suspicious activities while approaching the targeted area (Berkowitz, Tan & Uhrmacher, 2019).

Moreover, satellites could provide border security authorities with detailed images of high-risk areas where there is an increase in illegal border crossings. Thus, satellites could conduct wide area surveillance, as well as access remote areas. They could be used in a variety of activities, including for monitoring targeted border areas, disaster management, and search and rescue missions. Images from satellites could also help to detect illegal trafficking paths along a country's international borders. Regular traffic across a border area interferes with vegetation and soil and is likely to leave visible tracks that could be detected remotely by orbital sensors. Given this, border security agents would be able to compare several images taken by satellites of the same location at different times to identify changes in patterns and to observe new or different patterns of foot traffic.

Moreover, high-resolution satellite imagery is technology that could be accessed by many countries for real-time reconnaissance. Remote sensing technology has evolved to allow the production of high-resolution imagery, which is used in driving and walking maps. In addition, significant advances in scientific remote sensing measurements are of assistance to scientists who wish to observe a wide range of phenomena including storms, forest fires and pollution (Berkowitz, Tan & Uhrmacher, 2019; Defenceweb, 2018b; Duggan & Hinman-Sweeney, 2009).

Apart from aerial viewing of the border area, satellite technology could provide a multitude of communication platforms, such as voice, data and video communications to aircraft and ground vehicles on patrol along a country's border. Satellite technology also provides a platform to transfer data from one point on the globe to another point. The key benefit of using satellite technology for communication is its global reach. Since borderlines are often in remote areas, which usually are not covered by comitial telephone networks, the use of satellite technology would allow border authorities in various areas to share information, images, and videos of the border area. It also allows for cohesion, as well as the ability to function as a single unit. Satellite communication technologies are further used to connect border security assets such as boats, coast guard ships and camera-equipped surveillance aircrafts (Space and Satellites Professionals International, 2016).

Other applications of satellite technology are in linking automated radar surveillance equipment installed on the land or in maritime border areas to detect moving targets. Space-based technologies such as UAVs are also operated through satellite-based technology and share vital border situation awareness to border security officials. Furthermore, satellite technology could be used for navigation in the border security environment. Satellite navigation technology involves the use of satellites and ground receivers to determine latitude, longitude, and altitude. Considering that the task of securing borders requires extensive sharing of information about a wider area of operations and to various and widely dispersed border security assets, satellites become the most suitable assets to undertake this task (Space and Satellites Professionals International, 2016). In addition, GPS is another important feature of border security. GPS is a space-based satellite navigation system and radio navigation system that produces timing and location information in all climate conditions, nearby the Earth (Sivaramaganesh, Ramya, Gowtham, Bharathi & Jeevitha, 2004).

Countries using space technology for border monitoring and control include the US Department of Homeland Security (DHS) and other government agencies tasked with migration management and anti-smuggling efforts. The DHS collects and shares data obtained from reconnaissance satellites with agencies responsible for migration control and anti-smuggling tasks. These satellite technologies are capable of penetrating cloud cover and to detect chemical traces, as well as identifying objects inside buildings. Similarly, India uses satellite images to monitor disputed territories. The decision by India to launch a satellite to monitor its borders, particularly between Pakistan and Bangladesh, was part of the recommendations made by a special task force established to examine the possibility of using space technology to improve border management. The recommendations were subsequently accepted for implementation by the Ministry of Home Affairs. The RISAT-2BR1 is an all-weather radar image satellite capable of taking high-resolution images from outer space in all-weather conditions, including when it is cloudy. Alongside the launching of a satellite were short to long-term goals of procuring high-resolution imagery and bandwidth for satellite communication. Other plans included the development of ground segment and network infrastructure, which would be used to share satellite resources by various government agencies in India; and the development of a centralised archival facility for storing satellite images that would be used by various government departments. Another border security

function that relied on satellites is the deployment of border guards to remote border areas; this could also be coordinated through satellite communication (Gill, 2019; Kumar, 2019; *The Economics Times*, 2019).

On the African continent, Egypt is also exploring the use of satellite technology to monitor its 1200-kilometer-long border with Libya, and to provide important images and data about its border areas. A reconnaissance satellite will be of value to Egypt in monitoring its vast border areas and in assisting the Egyptian military to respond to security threats from Libya and Sudan. Images obtained from the satellite would give Egyptian border authorities a clear picture of the border environment. This satellite would be built by Energia, a Russian national rocket and space corporation (Megahid, 2018). The adoption of space technology to monitor Egyptian border arose from the difficulties experienced by the country to monitor its borders with Libya and Sudan, and its inability to respond effectively to infiltrations, including the illegal trafficking of arms and explosives, the smuggling of militants and drugs, and human trafficking. Despite the deployment of the army and the establishment of a military base in the western desert of Egypt, it continued to experience major national security challenges. The new EgyptSat, a satellite worth $100 million, is the second endeavour by Egypt to monitor its border using satellites. The first attempt by Egypt to monitor its borders using satellites was in 2014 with the launch of the Russian built EgyptSat 2, worth $45 million. Regrettably, Egypt lost contact with the satellite (Megahid, 2018).

Currently, Egypt is working on the launch of two new satellites, the MisrSat-II and the MisrSat-III, by 2023 and on the development of a NGEO constellation within the next six years. This constellation will conduct surveillance and monitor the Egyptian borders, as well as mitigate the risk of climate change, and grow the country's capability in space weather and space debris mitigation (Ibeh, 2020). Although not so well documented, South Africa also uses satellites to monitor activities, specifically on the South Africa-Zimbabwe borders. This technology assists South Africa to identify illegal migration hot spots, new illegal migration and smuggling routes, places where fences have been cut, wildlife poaching, as well as areas where vehicles are smuggled. Although a satellite may only pass over a certain area once or twice per day, it can be of value to border security agencies to identify several activities along the borders (Defenceweb, 2018b).

The Department of Science and Technology (DST) through its National Space Strategy (NSS) acknowledges that high-resolution satellite imagery could be used to monitor human trafficking, and distribution networks could assist in reducing this phenomenon. It could also be used to monitor the smuggling of drugs and the illegal movement of prohibited substances across borders. Moreover, the improvement of communications and information technology networks between decision-making bodies and organisational executives would be of value in any attempts to reduce these transnational risks (DST, 2018).

3.5.2 Unmanned Aerial Vehicles

There are two types of UAVs – drones and remotely piloted vehicles (RPVs). Both these types of UAVs do not have pilots. Drones are programmed for autonomous flight, whilst RPVs are actively operated remotely through a ground control operator. Thus, UAVs can be defined as a powered aerial vehicle, which does not carry a human pilot but uses aerodynamic forces to be lifted into space; are able to fly alone; or can be remotely piloted. They can also be disposed of or be recovered. Moreover, UAVS can be used to carry non-lethal or lethal payloads (Bolkcom & Nunez-Neto, 2008).

Narayanan and Ilbe (2015) define UAVs as another class of aircraft, which can be flown without the presence of on-board pilots. They (2015) further state that UAVs' systems typically consist of an aircraft component, sensor payloads, and a ground control station. UAVs can be controlled by on-board electronic equipment or via control equipment from the ground. When a UAV is controlled remotely from the ground, it is referred to as an RPV. RPVs would usually require reliable wireless communication for their control. In larger UAVs, control systems could consist of vehicle or trailer mounted systems, which offer proximity to UAVs that are limited by range or communication capabilities.

UAVs or drones are used for a wide range of activities, such as transportation, intelligence gathering and reconnaissance, and border surveillance. They are also used in the military to launch armed attacks. UAVs are automated and autonomous, as well as reliable (Shishkov, Hristozov, Janssen & Van Den Hove, 2017; Hartmann & Steup, 2013). Another advantage is their flexibility in providing their services at any given

time. It is for this reason that some governments, including the US and Switzerland, are considering the use of UAVs to improve their national security through surveillance and other military missions. This is done through the collection and processing of a variety of operational data, such as on the movement of persons, on the environment, and on strategic operations (Hartmann & Steup, 2013; Klauser, 2012; Klauser & Pedrozo, 2015).

Wilson (2018) indicates that UAVs offer several advantages, such as their ability to operate without an airfield; they have greater endurance as opposed to manned aircrafts; they are relatively difficult to be seen and avoided by smugglers; and are less expensive to operate. The author (2018) further mentions that UAVs can reach remote areas quicker than vehicles on the ground; and they can provide users with tactical space-based intelligence, surveillance and reconnaissance capabilities to enhance the effectiveness of patrol vehicles, boats and officials in the field.

UAVs can provide aerial surveillance of a border environment; thus, significantly enhancing the border monitoring efforts of troops on the ground. In the USA, UAVs patrol over 1500 kilometres of the border areas between Canada and the US on the Washington-Minnesota border and over 320 kilometres across the New York-Lake Ontario borders. The number of border guards in those areas has been increased since the 9/11 attacks but despite that, these border guards are augmented by various technological measures (MacLeod, 2009; Wilson, 2018). Larger parts of the US-Mexico border are monitored by UAVs alone, in a move by the USA that seeks to control remote stretches of the US-Mexico border by drones, where there are no border guards, fences, ground sensors or camera towers. These UAVs are also used to clamp down on illegal migration, drug smuggling and human trafficking activities (Payan, 2016; Sterman & Brauer, 2019).

A UAV can be operated by a single operator, which significantly reduces the number of personnel required to monitor the border. UAVs can send live images to the operator on the ground or if linked to a central command centre, they are able to send information through where a decision will be made whether to deploy border guards to that area or not. They are also very fast and can move to many regions of the border area quicker than foot and vehicular patrols, which enhances their ability to detect

border intruder (Marube, Odongo & Muchemi, 2017; Wilson, 2018). Similarly, in Switzerland, UAVs are part of the Swiss government's civil-military agenda. They are aimed at controlling and monitoring Switzerland's border areas by optimising its border surveillance and identification measures. This space-based technology allows Switzerland to fly over strategic spaces, such as the Franco-Swiss border space, and offers opportunities for the provision of new knowledge and border monitoring and identification practices (Ceyhan, 2006; Pedrozo, 2017).

Kenya and Nigeria are African countries exploring the use of drones to monitor their borders. In 2013, the USA and Japan offered to assist Kenya to purchase drones for border security and to curb small arms trafficking. This is an example of international collaborations and partnerships for border security and space technology (Wilson, 2013; Nkala, 2013; Bergenas, Stohl & Georgieff, 2013). In addition, the President of Nigeria, Muhammadu Buhari, has authorised the Nigeria Customs Service (NCS) to make use of drones to monitor the country's borders and to discourage the illegal movement of persons and goods into Nigeria. Moreover, in Nigeria, drones are used for security surveillance; intelligence gathering; anti-terrorism missions; and ultimately, to reduce the level of insecurity among Nigerian residents (Ofikhenua, 2019; Abiodun, 2020).

UAVs are an important border-monitoring tool when compared to border guards on patrol or other stationery border surveillance equipment. For example, they are better positioned to detect an illegal border crosser who attempts to cross international borders through densely populated regions or mountainous terrain along the border area. In these instances, UAVs have a greater chance than stationery surveillance equipment used at borders to identity and track an intruder through thermal detection sensors (Blazakis, 2004). Moreover, patrolling harsh and complex geographical environments, which could be dangerous for border guards, could be simplified by using UAVs to patrol border areas, while keeping the operators at a safe distance (Gadda & Patil, 2013; Liu et al., 2019).

Wasonga and Wambiro (2019) state that even though it is still early days for building more information and understanding how drones could be used to meet the security challenges of underdeveloped or developing countries, they could still offer

sophisticated, capable and intelligent results on security and defence matters. Moreover, drones can withstand adverse weather conditions and carry more payload.

Given the above, a UAV can be a useful tool for many applications in the field of public safety and security. Apart from border surveillance, it can also be used in disaster management activities, such as search and rescue missions during forest fires, landslides, volcanic eruptions and earthquakes. Other applications would be in traffic management. The monitoring of traffic flow near border areas and into a designated point of entry is another function of border security that could be achieved using UAVs (Pedrozo, 2016). Thus, UAVs have become a natural choice for many countries in conducting Intelligence, Surveillance and Reconnaissance (ISR) missions (Miao, Zhen, Wang, Lv & Qu, 2018; Manyam, Rasmussen, Casbeer & Kalyanam, 2017). This technology allows security structures to gather and analyse situations using three methodologies, inter alia trends and patterns, frequency, and probability, which ultimately provide solutions to large and expensive border security forces, and further enhance their ability to succeed in border security (Segell, 2005).

South Africa has been emerging as one of the major players in the development of military UAVs in recent years. Companies such as Denel Dynamics, Milkor, ATE and CSIR all have the capability to develop military UAVs concepts, inclusive of hand-launched drones with ISR capabilities and larger armed UAVs. For example, the Milkor MA380 drone is capable of undertaking long-endurance missions, which could be used for search and rescue activities, maritime patrols, and ISR missions. This drone has a flight endurance of 20 hours and can travel about 2000 kilometres. It could also be fitted with technology that could be used to send real-time images and videos to ground control staff (Milkor, 2018; Hussein, 2019).

Another example of a drone is the Denel manufactured Seeker 400, which has an electro-optical sensor suite consisting of a variety of technologies such as colour daylight and infrared thermal cameras; night spotter cameras; and an electronic surveillance payload capable of detecting radar emitters. Moreover, the CSIR developed Indiza, a small hand-launched drone consisting of three camera modules in the form of a pan, tilt and stow twin-camera system; a 3G mobile phone-based camera; and a towable high-definition wide-angle video camera (Denel, 2020; Martin, 2018;

CSIR, 2019; Martin, 2019). With the South African-based capability in drone development, these drones can be configured to meet the requirement of border security agencies in the country.

The application of various forms of space technologies is intended to provide border security authorities with situational awareness, which will enhance their operational reaction capabilities in respect of cross-border criminal activities, including the build-up of illegal migrants within the border area; and to gauge changes in the flow of illegal migration towards the border area under surveillance, which poses a threat to border security and could hamper the ability of border authorities to effectively perform their border management duties. They also provide the capability to monitor the border in real-time with accuracy and through minimal human participation. Historically, border patrol activities have been based on extensive human involvement. Moreover, border security authorities are required to cope with the complexities and the diverse nature of border threats and risks. This requires high patrol efficiency and fast reaction speed. Harsh terrain in most rural border areas and complex geographical conditions make it dangerous for border security officials to conduct manual patrols (Liu, Liu, Shi, Wu & Chen, 2018). Though, the costs of extensive human involvement, together with the diminishing accuracy of human-only surveillance methods, require the application of advanced technologies in border patrol (Sun, Wang, Vuran, Rodhaan, Al-Dhelaan & Akyildiz, 2011). Similar sentiments are expressed by Alkhathami, Alazzawi and Elkateeb (2015) when they state that border patrol systems and applicable techniques are meant to address national security concerns and a major challenge in protecting and patrolling long stretches of land borders is the need for intensive human involvement. However, the invention of various technologies helps to minimise the need for such intensive involvement.

3.6 Potential limitations of using space technology for border security

Although space technologies can enhance border security, they are not without limitations. For example, UAVs are regarded as highly exposed technological systems and might be prone to system attacks. An attacker might access the UAV's operating system and influence its operation externally. GPS spoofing attacks are a vulnerability of UAVs. Attackers will use spoofed GPS signal to provide a falsified estimation of

the UAVs current position or, in certain instances, sending the UAV to an incorrect positioning. Moreover, the information collected and carried by UAVs makes it a greater target for espionage. This exposes UAVs to theft, manipulation, and cyber-attacks (Hartmann & Steuo, 2013).

Another limitation of UAVs relates to the difficulty in positioning them to conduct border surveillance; this is caused by the absence of adequate ground infrastructure (Bier & Feeney, 2018; Szechtman, Kress, Lin & Cfir, 2007). Another factor for consideration in the use of UAVs in border security is the influence of the environment on communication links. Although many designated border posts have power and communication systems for effective border operations, remote border areas, which constitute a large part of the border environment, often lack the necessary power and communication infrastructure to enable the application of various technological instruments. Moreover, poor road infrastructure hampers the deployment of technology to larger parts of the border area (Hartmann & Steuo, 2013).

Some UAVs are sensitive to poor weather conditions, such rain or heavy fog. These unfavourable weather conditions affect UAV surveillance operations and often lead to changes in the patrol route; thus, changing the pattern of surveillance and the targeted areas. In other instances, border security authorities will abandon drone engagements due to climatic factors (Coeckelbergh, 2013). Rough terrain and dense vegetation, as found in most border areas, could negatively affect the quality of images produced by a UAV's sensory equipment; thus, limiting its effectiveness in the border environment (Yaacoub, Noura, Salman & Chehab, 2020).

Climatic conditions could also cause failures in UAV control systems and result in accidents. Unlike manned aircrafts, there is no well-trained pilot onboard to find the source of the problem and steer the aircraft to safety. UAV pilots are removed from the event and, due to their proximity, are not always well positioned to identify the source of the problem (Butler, 2002; Boucher, 2015). However, the use of UAVs eliminates the safety concerns faced by pilots of manned aircraft on patrol (Yaacoub, Noura, Salman & Chehab, 2020).

Drones emit a loud noise, which limit their ability to sneak discretely into an open space; thus, they are seen and heard by the targets of surveillance (Hartmann & Steuo, 2013). Poor communication networks in remote areas, such as border areas, could also affect the functioning of technologies such as UAVs (Dean, 2020). Other non-technical aspects of UAVs are the nature of collaboration between various role players, including pilots, operators, border guards, and technical teams. The skills and training of these actors are critical in the operational effectiveness of UAVs. The ability to collaborate effectively is dependent on clearly defined roles among these role players, a well-defined operational strategy, and an institutional hierarchy (Coeckelbergh, 2013). There are also legal considerations and privacy issues that come with the operation of UAVs, especially in border areas. UAVs could have limitations regarding flying in certain areas. The use of UAVs is subject to numerous legal requirements, such as licensing issues and aspects of international relations. They cannot be flown in areas where there is a high presence of commercial flights (Bolkcom & Nunez-Neto, 2008; Bier & Feeney, 2018).

UAVs can only be flown over private properties and over international borders. When in operation in border areas, they collect large amounts of information about residents along the borderline. Thus, to minimise privacy implications, avoid legal disputes, and maintain good diplomatic relations with neighbouring countries, the use of UAVs in the border areas should take into consideration the disputes that might arise from their application. UAVs must be used solely for border surveillance operations and should be operated more inward, rather than beyond a country's borders. Drone pilots also need to be aware of and comply with legal and privacy requirements relating to the operation of UAVs (Bier & Feeney, 2018; Dean, 2020). There are also cost implication relating to the procurement and operation of UAVs. The costs of operating UAVs could be higher than the costs of operating manned aircrafts (Bolkcom & Nunez-Neto, 2008; Bier & Feeney, 2018). Introducing UAVs for border security would necessitate the training of UAV pilots, which would bring about additional financial costs (Pedrozo, 2016).

The use of satellite technology for border security holds other challenges. Many developing countries do not have the necessary capability and expertise to produce satellite technologies and provide support to users using local resources. This could be

a barrier for those countries to expand the use of satellite technologies, including for border monitoring. In addition, the lack of personnel with the requisite capacity to generate space technologies applications could be another limitation for the application of space technology for border security. Moreover, restrictive access to data, inappropriate data, a lack of data, which is ready for analysis, and inadequate observation are some of the limiting factors of the use of satellite technologies, mainly in developing countries (Organization for Economic Cooperation and Development, 2019).

A further limitation of satellite technology is the impossibility of permanent 24-hour-a-day surveillance of border areas using satellite sensors. A further limitation is their inability to penetrate forested areas to detect humans and to find suspicious objects, such as hidden vehicles hidden, or to differentiate between types of vehicles (Malinowski, 2010). Romeo, Pacino and Borello (2009) state that several satellite technologies used for earth observation are not suitable for continuously engaging in real-time border surveillance due to their limited spatial resolution. Similar to UAVs, the principles of international space law and privacy issues must also be considered before a country can engage the services of satellite technology for border security. This becomes more pertinent when such technology is used by the military (Best & Elsea, 2011; Lee & Steele, 2014; Willis, 2017). Historically, satellite technology was controlled by a handful of government departments. However, satellite technology has progressed significantly over the years and is now accessible to many private corporations. As such, this has increased the risk of abuse of this technology, such as industrial espionage and illegal spying activities (Willis, 2017).

3.7 Chapter summary

This chapter highlighted the importance of space-based technologies to solve socio-economic challenges. It also indicated that space technologies are being developed and used by many countries, including South Africa, for remote sensing, navigation, and communication. Considering this, the ability to sense, launch, navigate and communicate are critical elements of any security mission, including border security. Moreover, this chapter indicated that navigation and communication satellites, remote sensing technologies, and aerial vehicles have become an important technical measure

for border security and these technologies need to be deployed to support the human element of border security. This is in due consideration of the fact that patrolling long and dense border areas in vehicles or on foot is not only impractical, but also dangerous for the human element of border security.

This is also relevant in South Africa since most of the South African land border environment is situated in remote and rural areas where there is wildlife in some of these areas. As such, the application of a variety of space-based technologies could offer benefits to border security efforts in South Africa, especially considering that the country is a developing country with space technology research and development capability, as well as a country that embraces partnerships with the academic and private sectors, especially where the state does not have the capacity to deliver the required infrastructure, goods, or services.

The integration of various socio-technical aspects of border security becomes an integral part of a complete border control and management system. A combination of incompatible and outdated methods of border surveillance and control will not be beneficial to border security efforts. As established earlier in the research, in the South African context, the vastness of the international border, unfavourable terrain and typology in most border areas, and human and physical resources constraints aggravate the challenges of border security in the country.

CHAPTER 4

PUBLIC-PRIVATE PARTNERSHIPS

4.1 Introduction

Budget deficits, lack of expertise and innovation, and a\the need for greater efficiency in the public service have compelled several countries to adopt alternative methods of delivering a variety of public infrastructure and services such as transportation, schools, prisons, hospitals, waste management, and water treatment. Alternative methods of providing public infrastructure and services used by many countries consist of the total privatisation of state-owned enterprises; contracting out of certain public services; and/or using private finances to provide social infrastructure and services (Cuttaree, 2008; Dulaimi, Alhashemi, Ling & Kumaraswamy, 2010). Against this background, partnerships between the public and private sectors are being acknowledged by many countries as an alternative to the traditional methods of providing public infrastructure and services solely through state entities (Kent, 1998; Webb & Pulle, 2002).

Partnerships between the public and private sectors allow these two sectors to blend their expertise and skills to achieve an outcome that would not necessarily be achieved by a single sector. Moreover, partnerships between the public and private sectors afford these two sectors a long-term sustainable method of delivering public infrastructure, improving public service delivery, and enhancing the value of public infrastructure (Akintoye, Hardcastle, Beck, Chinyio & Asenova, 2003). Considering these factors, this chapter seeks to explore the general theories of Public-Private Partnerships (PPPs), the forms and structures of PPPs, and the costs and benefits of PPPs. In addition, this chapter will look at the characteristics of PPPs, the elements and key drivers of PPPs and the key success indicators of PPPs. Furthermore, this chapter will provide a historical overview of PPPs in South Africa. Lastly, this chapter will briefly discuss the application of PPPs in national security projects and space technology projects.

4.2 General theories of public-private partnerships

The world has experienced significant expansions in the development of public infrastructure since 1950. As a result, governments were unable to provide public infrastructure and services themselves. This prompted governments across the globe to enter into partnerships with private organisations to increase their involvement in providing public infrastructure and quality services. In this regard, several initiatives such as the privatisation of state-owned enterprises, contracting out of certain services, and the use of private finance in the provision of social infrastructure became the necessary instruments (Nielsen, 1997; Siemiatycki, 2012; Dulaimi, Alhashemi, Ling & Kumaraswamy, 2010). This section of the study seeks to discuss the general theories that underpin PPPs by exploring the various definitions of PPP; analysing the difference between PPPs and privatisation; and further exploring the difference between contractual and institutional PPPs.

4.2.1 Definition of public-private partnerships

A proper understanding of the meanings associated with PPPs serves as a basis for understanding what is to be valued, believed in, and aimed for in the context of this concept (Humphrey, 2005). However, there is no single definition of a PPP, which academics and practitioners could agree on (Levai, 2012; Cruz & Marques, 2013). Although there are several definitions of PPPs, each of the identified definitions speaks of selected PPP features and, as a result, different scholars understand the term differently (Mouraviev & Kakabadse, 2016).

Crawford (2003), Neal (2010) and Hodge and Greve (2007) state that there is an absence of an exact and comprehensive definition of PPP since the meaning and practice of PPPs are elusive, wide ranging, and lack definitional clarity. Nonetheless, many scholars have attempted to define the term PPP by elaborating on its characteristics, and demonstrating its functions, elements, components, and underlying assumptions. In an attempt to reach a more precise definition of PPP, some scholars have made distinctions between different types of partnerships based on the reasons that brought the relevant partners to work together and the nature and level of the

relationship that binds those partners together (Webb & Pulle, 2002; Monsma, 2004; Vining & Boardam, 2008).

Given the above, Farlam (2005) defines a PPP as a contract between a public sector institution and a private party where the private party assumes substantial financial, technical, and operational risks of the project. Greemsy and Lewis (2002) further define a PPP as long-term contractual agreement between public sector and private sector bodies for the construction or management of public sector infrastructure facilities by the private sector entity, or the provision of services by the private sector entity on behalf of a public sector entity. A further definition is outlined by the Canadian Council for Public-Private Partnerships (CCPPP, 2009), where the term PPP is defined as a cooperative venture between the public and private sector, which is built upon the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks, and rewards. In broad terms, Byiers, Große-Puppendahl, Huyse, Rosengren and Vaes (2016) define a PPP as a policy approach, which involves public support for private investments with the main aim of achieving certain public benefits alongside private profit based on the principle of shared risks and responsibilities.

Considering the varying definitions herein, Mouraviev and Kakabadse (2016) suggest that even though governments might adopt their own positions regarding the forms of partnerships to adopt, they stand to benefit from using terminology and concepts that have already been expansively discussed in international literature. This approach is also likely to make PPP policy clearer and more attractive to private investors. In the South African context, a PPP is regarded as a commercial transaction, which involves a public institution and a private party where the private party performs an institutional function on behalf of a public institution for a specified or indefinite period. In other instances, a transaction in a PPP might entail the use of state property by the private party for its own commercial purposes for a specified or indefinite period. In this partnership, a private party derives a benefit for performing the function or, in some instances, by utilising property owned by the state. A benefit could be through compensation from a revenue fund; charges or fees collected from end users or customers by the private party in respect of a service provided to them; or in certain

instance, a combination of such compensation and such charges or fees (Treasury Regulations, 2005).

4.2.2 Difference between public-private partnership and privatisation

According to Fourie and Burger (2000), misunderstandings could arise when the term PPP is defined, as this term is usually confused with privatisation or subsidisation. The authors (2000) further state that this misunderstanding could possibly lead to the concept of PPP being viewed in a negative light by those opposing privatisation. Against this background, Shirley (1992) defines privatisation as the transfer of ownership of assets from the public sector to the private sector. Thomson and Kay (1986) also define privatisation as a process of changing the relationship between the government and the private sector. This process would include denationalisation and contracting out. A controversial definition of privatisation is provided by Boycko, Shleifer and Vishny (1996). They (1996) define privatisation as a process of corporatisation, which entails turning over the control from spending politicians to managers. Yarrow (1999) further defines privatisation as a political strategy, which creates a set of new rules and assigns new roles to the state, the market and civil society. Hence, Savas (1987) distinguishes between four categories of privatisation, that is: ideological, populist, pragmatic and commercial.

The argument behind privatisation is always that the private ownership of entities and processes is more efficient in delivering services, compared to the state (Yarrow, 1999). This argument is supported by Sheshinski and Lopez-Calva (2003) when they state that the four main objectives of privatisation are to achieve higher allocative and productive efficiency; to reinforce the role the private sector plays in the economy; to improve the public sector's financial position; and to free resources for allocation in other important sectors such as social policy. Privatisation could take the form of the partial or total day-to-day running of public institutions at any level of the public sector. A variety of methods and procedures can be applied to privatise public institutions, which could include liquidation, the sale of shares, the sale of assets, and the sale of leases and concessions. However, Boycko, Shleifer, and Vishny (1996) comment that privatisation becomes more effective when combined with a tight monetary policy, and when the new owners of the privatised institution are profit-maximising investors.

In contrast to privatisation, PPP projects are usually developed by a public sector entity at a local or national level through a public procurement process. In this case, the public sector entity is responsible for the task of providing infrastructure, goods or services and acts as a grantor in the form of a PPP. Moreover, the public sector entity involved in a PPP is responsible for designing an applicable regulatory framework and issuing permits and licences. In certain instances, a public sector entity can be a project sponsor, or a joint venture can be agreed upon where more than one sponsor is involved (Wojewnik & Wegrzyn, 2019). Unlike in privatisation, where the ownership of public assets is permanently shifted to a private body, in a PPP, the state is constantly liable to discharge certain public duties even though the intervention of the private sector is obtained in different modes.

4.2.3 Contractual and institutional public-private partnerships

PPPs are generally understood to be specific projects carried out in collaboration between public institutions and private bodies to provide a variety of public infrastructure or services, as discussed earlier. PPPs consist of two basic types. The first type entails the utilisation of state property by a private body for its commercial goals. The other type of PPP involves performance by the private party of services of a public institution. Thus, PPPs could be classified as being contractual or institutional. In an institutional setting, both the public and private partners work jointly in the establishment of an entity (Renda & Schrefler, 2006; National Treasury, 2004).

4.2.3.1 Institutional public-private partnerships

The institutional function performed by the private party could include any service, assignment, task, or other function that an institution generally performs on behalf of a public sector institution (Renda & Schrefler, 2006; National Treasury, 2004). Institutionalised PPPs can be established through joint participation between a public institution and a private body or by allowing a private body to buy and own shares using an existing company. In other instances, a private body might enter into a contract with a municipality to provide services, such as in countries like Italy, Hungary, and the Czech Republic, where the provisioning of water is partially owned by a municipality and partially owned by a private company under contract to run the water

services. In most instances, a public institution controls the company either as a shareholder or through other special rights it might possess, and the private body controls the service. This appears to be a positive cooperation as the public institution retains control over the infrastructure services. Moreover, in this set up, a public institution might derive benefits, such as the freedom to adjust in accordance with the changing environment; the ability to internalise the process of resolving organisational conflict; and the advantage of acquiring organisational expertise from working jointly with the private party (Hall, 2008).

A negative aspect of institutional PPPs, such as those with terms of between 30 and 80 years, is that they might have a lengthy lifespan, stretching to future generations, and they might be inconsistent with the specific needs of the future generation (Kouzmin, 2009; Parker, 2012; Johnston & Kouzmin, 2010). Thus, it can be argued that in an institutional PPP, governments create long-term financial commitments for future generations and taxpayers, who are unable to vote in favour of or against any of the contracted PPPs. Therefore, future generations are likely to face higher taxes and budgetary constraints because of the increasing burden on government finances over an extended period when governments are compelled to continue with compensating PPPs for assets constructed and services that have been rendered.

4.2.3.2 Contractual public-private partnerships

Contractual PPPs are arrangements where a private body provides a service to the public on behalf of a public authority, although the latter remains in control. The arrangement is largely dependent on the characteristics of the contractual relationship and the tasks delegated to the private body. An example of a contractual PPP is whereby a private body is tasked with the development of urban infrastructure on behalf of a public authority. The private body takes all the responsibility for the construction, operation, and maintenance of the infrastructure by charging the end user for the services rendered. In this instance, there is a direct link between the private body and the end user. This model has been widely used to offer public services such as health, education and roads, where periodic payments are made by the public institution to the private body for making the infrastructure available. Contractual PPPs could also take the form of a build-operate-and transfer arrangement where the private

body builds, operates the infrastructure, and transfers it to the public body at the end of the contract. Similarly, build-own-operate-and-transfer arrangements could be entered into between the public and private parties where the ownership of infrastructure is under the private party during the contract term as part of a contractual PPP (Weber & Alfen, 2010; Cappellaro & Longo, 2011).

4.2.4 Role of public private partnerships

PPPs have been a feature of service delivery in several countries in recent years and have emerged to be an important alternative to the conventional approaches of public service production and delivery, and the realisation of large infrastructural projects (Cuttaree, 2008; Webb & Pulle, 2002; Nederhand & Klijn, 2019). PPPs were originally used in the USA in the 1960s to give effect to urban development projects involving private investors. This resulted in the rapid recognition of PPPs throughout the world. In the 1990s, the United Kingdom (UK) incepted what was termed a Private Finance Initiative (PFI). PPPs continue to be globally recognised as an alternative method applied by the public sector for the procurement of services and goods, such as in the area of social and economic infrastructure management (Spackman, 2002; Alfen, 2010; Fosler & Berger, 1982).

PPPs have been employed in many projects to procure public works and services globally. During the initial inception of PPPs, the focus was mainly on public infrastructure projects such as roads, prisons, railways, and power generation. However, PPPs have been expanded to provide social infrastructure, such as schools, health services, and hospitals (Colverson, 2011; Osbourne, 2000). It is evident that PPPs have been accepted by several countries and will continue to be used by various governments around the world to deliver public infrastructure and render public services (Klijn & Teisman, 2000; Mouraviev & Kakabadse, 2016). The main idea behind the concept of PPPs was to reposition the relationship between the public and private sectors in line with the principles of New Public Management (NPM) (Mistarihi & Kwasawneh, 2015). Thus, PPPs are guided by a belief that public authorities and private sector organisations working together in a meaningful partnership are likely to deliver mega-projects with better outcomes than any one party could deliver on its own (Osborne, 2000). In most instances, one actor does not have all the requisite skills,

resources, and expertise to deal with an array of policy issues relating to public service delivery and the provision of public infrastructure. Therefore, the strength of the partnership approach in achieving the delivery of mega projects though a PPP arrangement is dependent on the proper alignment of the interests of both parties (McQuaid, 2000).

4.3 Management and structures of public-private partnerships

Approaches to PPPs vary from one country to another. Moreover, the growing literature and discussions about PPPs often cause confusion due to dissimilarities in the terminology that underpin the concept of PPPs (Mouraviev & Kakabadse, 2016). As discussed earlier in this study, PPPs are generally developed to serve public interests, such as when a government enters into a partnership with the private sector in order to deliver infrastructure such as roads, bridges, ports, railways, airports, health facilities, and prisons (Osbourne, 2000; Cruz & Marques, 2013). Against this background, there are different types of PPPs in existence worldwide. They include Build-Own-Maintain (BOM); Build-Own-Operate (BOO); Build-Develop-Operate (BDO); Design-Construct-Manage-Finance (DCMF); Design-Build-Operate (DBO); Buy-Build-Operate (BBO); and Lease-Own- Operate (LOO) (OECD, 2008; Posner et al., 2009; South Africa, 2019). These models might appear to be self-explanatory, but it is important to analyse each of the models and briefly discuss the impact of each model.

4.3.1 Design, Build, Operate and Finance (DBOF)

The Design, Build, Operate and Finance (DBOF) model is a partnership between the public and private sectors, which involves the design, construction, operation, and financing of public infrastructure or facilities. The private party is responsible for designing, building, operating, and financing the infrastructure, and proceeds with the recovery of the costs only from the payments from the public sector. This is mainly dependent on the private party's ability to meet the pre-approved output specifications as part of the performance mechanism (South Africa, 2018; United Nations Economic Commission for Europe, 2012).

Although the private body is permitted to be innovative when designing the facility to minimise costs, the facility should be designed as per the specifications proposed by the public authority. What remains critical is to bear in mind the costs associated with the maintenance of the infrastructure during the design process. Moreover, designing the infrastructure to be used for multiple purposes will ensure that the return on investment is high (Grimsey & Lewis 2005; Smith 2000). In this model, the private party absorbs the risks that come with the main functions of the project, such as design, build, operate, and finance. The duration of the partnership is normally between 25 and 40 years; the ownership of the facility is transferred to the public authority at the end of the term (Coulson, 2005).

4.3.2 Design, Build, Finance, Own, and Operate (DBFOO)

In the DBFOO model, the private body retains permanent ownership of the infrastructure and operates the infrastructure on a contract. The role of the public authority in this arrangement is simply to purchase the services from the private party. This becomes a service procurement arrangement rather than a procurement arrangement. In this arrangement, should the infrastructure be built on land owned by a public body, the private party would be constrained to use such as facility for purposes that are not in line with the wishes of the public body after the contract ends, unless the contract covers such usage. Therefore, it would be better suited to build such infrastructure on premises owned by the private owner (Grimsey & Lewis, 2005; Scharle, 2002; Zhang & Kumaraswamy, 2001).

4.3.3 Joint venture

In a joint venture, the public authority and the private party assume co-responsibility and co-ownership in an organisation. The resources of the public and the private sectors are pooled to generate shared resources (Akintoye et al., 2003). Therefore, the returns derived from operating the infrastructure or assets are proportionally shared between the public authority and the private party against the investment of each party. Although the management of the infrastructure is done jointly by the public authority and the private body, the day-to-day management of the infrastructure is often carried

out by the private body (Trafford & Proctor 2006; Becker & Patterson 2005). The risks pertaining to the project are also shared by both the public and the private body.

4.3.4 Concessions

In a concession, the service provider, who is a private party, recoups the costs associated with the construction of the infrastructure through direct user charges and government subsidies. The public body could be given exclusive rights to operate the infrastructure and deliver the required services during the term of the contract, but it has to pay the private body for those exclusive rights. This requires some regulation by the public body in order to avoid exploitation by the private party. The private party is further expected to invest in the improvement of the facility and thereafter pass the costs to the consumer. A concession is appropriate if there is the sale of outputs directly to consumers. Concession contracts have a lifespan of 30 years or longer (Yescombe, 2011; Plummer, 2002; Saussier & De Brux, 2018).

4.3.5 Design, Build, Finance, and Transfer (DBFT)

In the Design, Build, Finance, and Transfer (DBFT) model, the private body is responsible for the design, building and financing of the infrastructure or asset. Once the infrastructure is completed, it is transferred to a public body for utilisation. Thus, the partnership between the public body and the private party is limited to the construction of the facility or the delivery of the asset. The public body will be responsible for the operation, or the delivery of services associated with the facility or asset. However, the relationship between the public body and the private party does not always end as soon as the infrastructure or asset is transferred to the public body. In some instances, the relationship between the two parties continues when the public body is expected to recover the cost of the construction and the private body is responsible for the maintenance of the infrastructure or asset for a determined period (Blacke, 2004; Shaw et al., 1996; Yescombe, 2011).

A drawback of this model is that the private sector does not stand to benefit from the expertise of the private body in the management or operation of the infrastructure. The perception exists that the private sector surpasses the public sector when it comes to

efficiency and management practices. Thus, the immediate transfer of the infrastructure to the public body deprives the public body of the opportunity to learn from the innovation and responsiveness of the private sector (Blacke 2004; Smith 2000). In certain instances, such as in national security projects, it might be justifiable to hand over the infrastructure to the public authority for operation, as the private body might not be adequately positioned to handle such projects. Although PPPs might differ in form and structure, there is always a contractual agreement between the public authority and the private party, which spells out the roles and responsibilities of each participant; thus, resulting in some form of risk sharing and risk transfer. Some PPP projects are self-sustainable as they provide a revenue stream to the private party, which allows for a profitable project without further support. If revenue streams are adequate, there might be concessionary payments to the public sector. In some PPPs, revenues are generated by the operators, but they could require financial assistance from the public body for the projects to remain profitable (Akbiyikli, Eaton & Turner, 2006). In the South African context, the various models of PPP projects that have been implemented are DFOs, DFBOTs, DTs, BOTs, and equity partnerships. These projects include hospitals, transport and roads, tourism, and head office accommodation projects (Kwak, Chi & Ibbs, 2009; South Africa, 2019).

4.4 Components of public-private partnership

As per the definitions, forms and structures of PPPs discussed above, PPPs consist of four components and role players, namely the public sector, the private sector, members of the public, and partnership agreements.

4.4.1 Public partner

Although it is not always clear whether an organisation should be defined as a public sector organisation or not, in general, the public sector refers to governments and all publicly controlled or funded agencies, enterprises and other entities mandated to deliver public programmes, goods or services (Dube & Danescu, 2011). Pathirane and Blades (1982) define the public sector as a set-up consisting of general government, public non-financial, corporate, and public financial institutions. Similarly, Christensen, Laefreid, Roness and Rovik (2007) describe public organisations as

organisations involved in public policymaking and implementation through the public managerial processes where policy makers decide on who gets what, when and how. A public partner could be a public sector institution such as a national state department, a provincial department, a municipality, or a city, which needs infrastructure, a facility, assets or services in order to give effect to some public policy position. The public sector holds the legal authority to execute a country's public policies. It also has a set of skills and assets that it brings to the partnership. Thus, a decision to involve a private party in the deliverance of a public infrastructure, a facility, an asset, or services is predominantly determined by the public authority. Against this background, it becomes imperative that the public sector creates a legal and institutional environment that is conducive for the private sector to participate in the socio-economic activities of a country. In collaborating with a private party, the public partner expects improvement in the performance of a programme, cost-efficiency, improved service delivery, and a proportionate allocation of risks and responsibilities (Keane & Weerasinghe, 2017; Pongsiri, 2002).

4.4.2 Private partner

The functions of the private party in a PPP comprise the design, construction, financing, and operation of the project. Since PPP projects require multiple sets of skills, the private party could bring together different companies as a single partner, with the public authority being the other partner. The private sector is known for its complete resources and its capacity to acquire more resources for economic activities. Capital goods are also predominantly found in private markets because they are mainly manufactured by the private sector. Moreover, innovation, dynamism and most technological developments are found in the private sector. Therefore, the private sector can be viewed as a base for good managerial skills, professionalism, and advanced technology (Scharle 2002; Kerr 2003).

Although the private sector is profit driven, the capacity and resources it has makes it a more attractive party for inclusion in a PPP in order to give effect to public policy. However, in order to have a successful project, a sustainable partnership must exist, which will enable the private party to generate profit out of the partnership and realise a positive return on investment (Jamali, 2004; Nisar, 2007).

4.4.3 Members of the public

Members of the public are largely the beneficiaries and the recipients of the services rendered through PPPs. This makes them the most significant part of a PPP arrangement. Hence, it is of paramount importance for members of the public to be able to embrace the provision of public services through PPPs (Carley, 2006; Sadran, 2019). An example in the South African context was the debacle of the Gauteng Province's e-toll system where members of the public were generally not in support of the user-pay system, were against the payment of e-tolls, and ultimately enabled the private party to derive benefits out of the PPP.

4.4.4 Public-private partnership agreements

As defined earlier, PPPs are agreements between a public authority and a private party. This agreement is usually contained in a contract, which spells out the duties and responsibilities of each party (Kroukamp 2004; Nisar, 2007; Grimsey & Lewis 2000). The contract should further define the nature of the partnership, the commitments of each party, and the rules of engagement. This will ensure greater cooperation between the parties. The absence of a clear, predefined agreement between the parties often leads to the collapse of the PPP. The complexity of PPP projects might require each party to involve legal experts when developing a PPP agreement (Houlde, 1990). Besides spelling out what is expected of each party, a written agreement will further serve as a point of reference should any dispute arise during the execution of a PPP project (Pongsiri, 2002).

4.5 Potential advantages and disadvantages of public-private partnerships

PPPs have been embraced by several countries as an enhancer of the provision of infrastructure and as a method to improve public service delivery. However, they have both positives and negatives, which prompts governments to analyse both the advantages and disadvantages of PPPs before deciding on whether to embark on a PPP, or not.

4.5.1 Potential advantages of public-private partnerships

PPPs bring on board the various skills and resources of both the public and private sectors through risk and skills sharing. This allows governments to benefit from the expertise and capacity of the private sector, and further allows governments to focus mainly on policy, planning and regulation by delegating day-to-day operations to a private party (World Bank, 2019). Roussouw, le Roux and Groenewald (2003) and Fourie (2006) hold similar sentiments when they state that a PPP provides an opportunity to spread development costs by combining two or more institutions in a temporary arrangement for a specific purpose. This further allows organisations with varying expertise to combine knowledge and resources to provide services effectively and efficiently.

There are many benefits offered by PPPs, such as an improvement in the quality and quantity of basic infrastructure in areas like water supply and treatment, energy supply and transportation. Moreover, PPPs can be extended to a public service such as hospitals, schools, prisons, and government accommodation. In terms of managing and containing costs, PPPs allow the public authority to complete the project according to plan and budget. This assists the public authority in developing a more disciplined and commercial approach to infrastructure development, whilst allowing for the retention of strategic control of the overall project and service. PPPs can yield benefits to countries that adopt them if there is a legal and regulatory framework; adequate technical skills to manage the PPPs; and proper project design (Miller, 2008).

Considering the above, some benefits of PPPs can be listed as follows:

- PPPs provide better public infrastructure solutions as opposed to initiatives that are implemented by either the public sector or the private sector. PPPs allow each participant to do what he/she does best. Moreover, projects undertaken through PPPs are completed faster and experience reduced delays. This is due to clear delivery targets and the need of the private party to reduce wastage by completing the project within the specified period. Early completion bonuses could be earned by the private party if they complete the

project earlier than planned; thus, encouraging the private partner to complete the project within the stipulated timeframe.

- Better financing opportunities are available when the public sector and the private sector work together. PPPs provide greater innovative design and return on investment when compared to projects that are undertaken through traditional all private or all public sector fulfilment. This allows government budgets and budget shortfalls to be reduced; thus, allowing the government to redirect funds to other socioeconomic projects.

- Project risks are fully appraised timeously to determine project feasibility against expectations. In addition, the private sector has the experience in cost containment. This position allows the transfer of operational and project execution risks to the private participant.

- Importantly, PPPs supplement limited public sector capacities to meet the growing demand for infrastructure development. They also provide an opportunity for the private sector to introduce technology and innovation to the public sector; thus, providing better public services through improved operational efficiency. Governments are also able to attain and maintain infrastructure throughout the life cycle of the project through PPPs (Osborne, 2000; Bruxel, 2005; Gaffey, 2010).

4.5.2 Potential disadvantages

A negative aspect of PPPs is that they are viewed as a form of privatisation by trade unions who are opponents of privatisation. Their main concern is the perceived erosion of job security and the acquired rights for their members. Another negative aspect of PPPs is that the private party is driven by the need to make profits and, if not carefully managed, the private party might exploit members of the public when rendering services. Moreover, public servants who fraudulently use their own companies or those of relatives to provide service in a PPP arrangement are a cause for concern. Thus, if PPPs are not managed well, there is a likelihood of mismanagement of public finances through unauthorised, fruitless, or wasteful expenditure (World Economic Forum,

2005; Public Service International, 2017). Considering this, PPPs come with the following costs:

- PPPs involve some risks for the private participant. Thus, the acceptance of those risks by the private party could increase the cost of the project.

- The presence of a limited number of private entities with the capability to complete a certain project, presents a challenge for the government. This might mean less competition and result in a less cost-effective collaboration.

- When the expertise to deliver a project lies heavily on the private participant, the government is likely to be at a disadvantage, such as being unable to assess the proposed costs accurately.
- There are costs attached to debt. Therefore, the private sector will only make it easy for the government to obtain finance if the financing of the project is expected to provide a return on investment. The cost of the project will be borne by either the customer or the government.

- The private participant will only do what it is paid to do, and no more than that. Therefore, it is important to have clearly stipulated incentives and performance requirements in the contract (World Economic Forum, 2005; Paul, 2007).

PPPs are not immune to the public sector and private sector pandemic of corruption. They are, as is the case with any other government projects, also susceptible to corruption. For example, Sclar (2000) states that there always are differences regarding contract duration, design, and the composition of actors involved in such partnerships; thus, making these partnerships vulnerable to corruption.

Liu and Mikesell (2014) state that at the pre-decision level, politicians might decide to render a specific infrastructure project through a PPP. This decision might lead to the misallocation of resources, for example, in favour of sectors or companies that are prone to corruption. According to Wells (2015), numerous studies have indicated that

despite the benefits offered by PPPs, corruption can occur at any stage of a project. Another possible risk of PPPs is a conflict of interest between the parties in the partnership, and a lack of trust (Thia & Ford, 2009). This is more prevalent when the different PPP functions create opposing incentives for each of the contracting partners.

As discussed above, PPPs confer some benefits to the contracting parties and each of the contracting parties has different motives to engage in PPP arrangements. Furthermore, the main aim of the private sector is to maximise profits, whilst the main aim of the public sector is to maximise public services, a function that is grounded in legislation, regulation, and political ideology (Jones, 1994). However, greater emphasis is placed on the following benefits that come with PPP arrangements: increased project delivery efficiency; enhanced operations and management; the availability of additional resources to meet the growing needs of investment in the sector; access to advanced technology; better management of capital spending; and greater innovation in the design, construction, operation, and maintenance of infrastructure over the lifespan of the contract. Moreover, PPPs create greater efficiencies and synergies between design and operation, and better the management of the project risk (Southern African Development Community, 2010; Valdimarsson, 2007).

4.6 Elements and key drivers of public-private partnerships

The key driver for involving the private sector in the provisioning of public infrastructure and services is to address public sector budget deficits and to search for greater efficiency, innovation, and creativity. In addition, PPPs are mainly driven by the need to satisfy growing infrastructure and service demands, and the expectation to construct new and upgrade existing ageing infrastructure (Grimsey & Lewis, 2004). Generally, PPPs provide a wide variety of net benefits for a government. According to Chan, Lam, Chan, Cheung and Ke (2009), the drivers for adopting PPPs are reasonable risk distribution, abridged public funding, cost saving and value for money, enhanced infrastructure quality and service levels, and substance for the economy.

4.6.1 Reasonable risk distribution

Risk distribution is defined by Hoffman (1998) as a process whereby potential and major risks in a project are identified and allocated to one of the project role-players. In a PPP project, risks are allocated to the party that is best able to bear and control those risks at the lowest cost. Moreover, it is necessary to match the returns of the project for each party to the risks they bear, in order to achieve economic equilibrium (Dialami, Lipkovich & Van Dyck, 1999; Fayard, 1999; Klein, 1998; Thobani, 1999). Considering this, the private sector is generally more efficient in asset procurement and service delivery than the public sector, and, as a result, it would be to a government's advantage to share the associated risks with the private sector (Boussabaine 2007; Chan et al., 2009).

4.6.2 Abridged public funding

PPPs provide an opportunity for the government to free up some of its fiscal funds for other projects and other areas of public service. It also improves cash flow management as high upfront capital expenditure is replaced by periodic service payments and provides cost certainty in place of uncertain calls for asset maintenance and replacement (Grimsey & Lewis, 2004). Consequently, the public funding required for public services can be reduced and redirected to support sectors of higher priority, for example, education, healthcare, and community services (Chan et al., 2009).

4.6.3 Cost savings and value for money techniques

PPPs are associated with cost savings. Cost saving refers to the ability of the public sector to reduce the cost of delivering a project by opting for a PPP arrangement as opposed to delivering public infrastructure and services through traditional methods (Chan et al., 2009). The reduction of costs could be as a result of the private sector's ability to be innovative and efficient, which are aspects the public sector lacks (Grimsey & Lewis, 2004; Akintoye et al., 2003; Li et al., 2005).

The private sector's ability to achieve higher operational efficiency in infrastructure and service delivery is mainly attributed to its experience, expertise, innovative ideas,

technology, and continuous improvements. Thus, cost saving in a PPP project could be achieved through the minimisation of the total costs of the project life cycle, while maximising profits (Chan et al., 2010; Hammami, Ruhashyankiko & Yehoue, 2006). Grimsey and Lewis (2004) define value for money as the optimum combination of whole life cycle costs, risks, completion time and quality in order to meet public requirements.

4.6.4 Enhanced asset quality and service levels

As indicated earlier in this chapter, innovation is one of the important elements the private sector can bring to a PPP arrangement. In general terms, the public sector may not be as innovative as is the private sector. The private sector builds its competitive edge and saves costs by regularly searching for new and better products and services (Klijn, 2009; Chan et al., 2009). Moreover, the private sector's responsibility is to ensure that the infrastructure and service delivered through PPPs meet quality benchmarks or standards throughout the life of the contract, as set out in the contract (Grimsey & Lewis, 2004).

4.6.5 Substance for the economy

PPPs provide private sector participants access to public sector markets and create business opportunities (Chan et al., 2009). Moreover, PPP projects can yield reasonable profits and positive returns on investment on a long-term basis. This will be dependent on how accurate pricings are and how effective costs are managed. Cooperation among parties to the agreement is also essential as PPP projects tend to be large and require various expertise from many areas (Chan et al., 2009; Grimsey & Lewis, 2004).

4.7 Key success factors of public-private partnerships

In business terms, critical success factors refer to elements that are essential for a company or project to achieve its goal. A company could apply the critical success factor method to determine the important elements of its success (Chan et al., 2010). Rockart (1982) defines critical success factors as those few critical areas of activity that are necessary for a manager to achieve his/her goals. Against this background, a

PPP project should benefit both the public and private parties. A PPP agreement should also create a conducive environment and render it more conducive for the private sector to participate in such arrangements. Moreover, measures must be put in place to ensure that projects and services delivered to the public through PPPs are of acceptable standards and quality (Zhang, 2005).

4.7.1 Favourable investment environment

The private sector and lenders are more likely to engage in PPPs when the environment in which the projects operate is conducive for business (Hayllar & Hui, 2010). For PPP arrangements to produce the desired results there should be favourable political, legal, economic and commercial environments for private sector participation (Zhang & Kumaraswamy, 2001). Against this background, a government is better positioned to create a favourable environment, which will allay the fears of the private sector on risks, including political risks (Zhang, 2005).

4.7.2 Appropriate risk allocation via reliable contractual agreements

One of the most important issues of a contractual arrangement in a PPP arrangement is the identification and allocation of risks. Other significant issues of a PPP contractual agreement are a clear statement of the objectives of the contract and the obligations and rights of the contracting parties, adequacy and clarity of plans and technical specifications, a formal dispute resolution process, and motivation and incentives for the contracting parties (Zhang, 2005).

4.7.3 Economic viability

Economic viability is critical to the success of any kind of project (Dulaimi et al., 2010). PPP projects are characterised by high capital outlays, long lead-times, and long operation periods with a broad range of risks and uncertainties. These uncertainties bring risk into capital investment evaluation decisions and, consequently, new methods have been developed (Dulaimi et al., 2010). Therefore, for projects that are not financially viable but of significant economic value, and that have political and

environmental objectives, governments should provide the necessary flexible project-specific support and/or guarantees to make them financially viable (Zhang, 2005).

4.7.4 Reliable concessionaire consortium with strong technical strength

While a government is in a better position to create a favourable environment for private sector participation in public infrastructure development in general, private sector participants play a paramount role in the successful implementation of PPP projects (Zhang, 2005). The significant realignment of risks among multiple project participants is a striking feature of the PPP scheme, in which the concessionaire undertakes many more commitments and assumes much broader and deeper risks than a mere contractor (Zhang, 2005). Therefore, the selection of the right concessionaire, which can be realised through a competitive tender process, is critical to the success of the project (Chan et al., 2010).

4.7.5 Sound financial package

PPPs in infrastructure projects are often financed on a non-recourse or limited recourse basis (Zhang, 2005). In this case, a variety of financial mechanisms could be used by parties to a project, such as debt, equity, mezzanine finance, contractor, supplier and purchaser credit, or sureties. A sound revenue stream for the project is the basis of project finance as lenders and investors have recourse to no funds other than this revenue stream, and assets of the project may or may not have any residual value (Zhang, 2005). Therefore, the financial package usually has a greater impact on the viability of a PPP project than the physical design or construction costs. Moreover, significant financial engineering efforts should be made to gear the great capital outlay of an infrastructure project to mesh with innovative financial instruments compatible with its projected cash flow (Chan et al., 2010).

4.8 Institutional and legal frameworks for public-private partnerships in South Africa

Infrastructure projects are characterised by large sunk costs, low mobility, area specificity and a high risk of opportunistic behaviour. These characteristics increase

investment risks on the part of the private investor. This means that before a private investor decides to invest in an infrastructure project, certain institutional conditions should have been met by the host country (Banerjee, Oetzel & Ranangathan, 2006). These requirements by private investors are legitimate, given the fact that once a private investor has invested in a country's infrastructure project, it loses its bargaining power, and the government can change the rules of the game as it wishes if there are no legal or regulatory frameworks that protect the interests of the private firm.

4.8.1 Institutional framework

An institutional framework can be described as a social mechanism or institutional arrangement in which an actor to a PPP can be held accountable by a forum. An institutional framework provides the actors with the ability to demand an explanation or justification from other actors for their actions and to reward or punish those actors based on their performance or explanation (Mulgan, 2003; Armstrong, 2005; Bovens, 2007). Considering this, many governments, including South Africa, have created specialised PPP units to develop and supervise PPP projects. Specialised PPP units have been of value, especially on the aspect of building internal capacity, as they allow for the availability and concentration of the required expertise and further facilitate adequate training and sharing of knowledge. In addition, PPPs units are long-term focused and provide support to the government in procuring PPP projects in a diverse range of areas or specific areas. When it comes to PPPs, which focus on the outsourcing of government provision of public goods and services, the PPP unit could be regarded as an instrument to delegate operational responsibilities to the private party regarding the provision of government services (Istrate & Peuntes, 2011).

PPP units are well positioned to support governments by setting up and supplementing PPP-related information, policies, and practices formation at national level. These units can be established and coordinated with the actors involved in the PPP programme at different governmental levels. However, much of the PPP units are set up in the Ministry of Finance or Treasury, as is the case in South Africa (Burger, 2006). The complexity of PPP contracts requires the public sector to monitor private sector consultants to ensure that public interests are achieved. This process requires a certain set of expertise, which the PPP unit holds. Therefore, a PPP unit can render support to

the public sector by applying the experience of specialists to streamline the processes of PPP procurement and make negotiations more effective (Ahadzi & Bowles, 2004; Istrate & Peuntes, 2011; Monteiro, 2005). Nevertheless, it might not always be necessary to create a dedicated PPP unit if the project deal flow is minimal. Experiences from countries such as South Africa, India and Kenya all prove that a solid PPP framework is a key pre-condition for a successful PPP. A well formulated PPP framework should be based on a clear identification and procurement process, a reliable and transparent judiciary to manage and handle potential disputes or complaints, and a piece of legislation with solid regulations for PPPs.

As is the case in other countries, including Canada, the UK, Australia and Italy, South Africa established a dedicated PPP Unit under the National Treasury in 2000 after the Cabinet commissioned a task team in 1997, which ran six pilot projects. Upon completion of the pilot projects, Treasury Regulation 16 of 2004 was issued under the Public Finance Management Act (PFMA). Treasury Regulation 16 sets out the rules that govern the development and execution of PPP contracts and prescribes a four-stage process for the approval of national and provincial PPPs by the National Treasury. These approvals are described as Treasury Approval I, IIA, IIB, and III. The PPP unit plays a crucial role in the creation of PPPs and has the final authority to approve PPP agreements, although the initiative and ultimate management of PPP agreements originate and rest with individual government departments and provinces (Burger, 2006; Dutz, Harris, Dhingra & Shugart, 2006; Irwin & Mokdad, 2010; Treasury, 2004).

In addition, the National Treasury also developed a manual, which sets out guidelines to contracting agencies from the project inception to the delivery of the project. In terms of the PPP manual, the project cycle can be broken down into two phases, namely, the project preparation period and the project term. Thus, the project phases are:

- **Phase I: Inception**

  During the inception phase, the project is registered with the relevant Treasury and a project officer is appointed.

- **Phase II: Feasibility Study**

  Phase II consists of the feasibility study. The feasibility study is conducted to ascertain the affordability and value for money of the project to be undertaken before the go-ahead can be given by the project team to proceed to the next phase.

- **Phase III: Procurement**

  In this phase, bid documents as well as a draft of the PPP agreement are prepared and signed off during the second approval process with Treasury Approval IIA. Potential bidders are pre-qualified in a Request for Qualification (RFQ) process and a Request for Proposal (RFP) is issued together with a draft PPP agreement. Thereafter, bids are evaluated, and the preferred bidder is selected.

  Treasury Approval IIB must be given first before the project can move to the next part of the procurement stage. In the next part of the procurement stage, the negotiation of terms takes place between the government and the bidder, and the PPP agreement is finalised. Treasury Approval III is further required to enable the parties to sign the procurement documents and progress to Phase IV.

- **Phase IV: Development; Phase V: Delivery; and Phase V: Exit**

  The final three phases consist of the development, delivery, and exit activities carried out by the contracted private party. During these phases, the measurement of outputs is carried out, performance is monitored and regulated, and disputes are settled by the contracting parties (National Treasury, 2004).

4.8.2 Legal framework

In many countries, PPPs are regulated through dedicated laws which cover the definition of PPPs; the creation and operation of the national structures responsible for promoting PPPs; the procedures for the preparation and approval of PPP projects before they are tendered; the tender process; the form and content of PPP contracts;

and the dispute resolution processes between parties to the contract. Infrastructure investments are vulnerable to opportunistic behaviour. Thus, the private sector needs to protect itself against any opportunistic risk that might arise during the execution of a PPP project. In this instance, investors rely heavily on contractual agreements and the legal and institutional frameworks that they are based on. Thus, investors tend to focus more on the legal environment governing contracts, property rights, contract enforcement, and the applicable rule of law before deciding to invest (Ramamurti & Doh, 2004). On the other hand, Scully (1988) argues that even if a PPP contract is well drafted, the presence of weak institutional arrangements will expose the contracting parties to opportunistic behaviour. The author (1988) further states that the presence of uncertainties within the legal system escalates transaction costs, which further affects competition in the market. In support of these assertions, Wildridge, Childs, Cawthra and Madge (2004) state that factors that are critical for the success of PPP include a regulatory environment and a strong legal system.

Considering the above, parties to a PPP agreement are required to adhere to the rule of law, which is often cited as legal accountability. Legal accountability ensures the realisation of laws and regulation, standards and norms, rights, and binding contractual agreements (Stone, 1995). Legal accountability measures are measures that further define the role and responsibility the judiciary and quasi-judiciary procedures exercise in ensuring the sound and reasonable execution of judgments in the civil, criminal, or quasi-judicial arena (Romzek & Dubnick, 1987; Koliba, Mills & Zia, 2011).

Closely associated with legal accountability is contractual accountability, which involves legally binding agreements on standards of performance between the contracting parties, written in specific, enforceable terms. This process comprises the creation of rights, obligations, and liabilities between two or more parties to a PPP arrangement that are enforceable through the judicial process (Dubnick, 1998). Therefore, an appropriate legal framework in PPPs could provide the necessary reassurance to the contracting parties that contracts will be honoured. In this light, Nyagwachi and Smallwood (2007) assert that an effective, credible and sustainable legal and regulatory framework is essential for promoting, fostering and implementing successful PPP projects in South Africa.

Considering the discussion above, the South African government has put in place legal instruments to guide all three spheres of government when entering PPP contracts. These legal instruments make it possible for the South African government to enter to into PPPs. According to Burger (2006) and Levinsohn and Reardon (2007), South Africa possesses advanced, clear, and the most developed legal frameworks for PPPs in the SADC region. These South African legal instruments are the Constitution, the Public Finance Management Act, Act 1 of 1999 and Regulations, the Broad Based Black Economic Empowerment Act, Act 53 of 2003, the Municipal Finance Management Act, Act 56 of 2003 and Regulations, the Preferential Procurement Framework Act, Act 5 of 2000, the Municipal Systems Act, Act 32 of 2000, the Treasury Regulation 16, the National Treasury Regulation Practice Note on PPPs, and the PPP Standardization Document (South Africa, 1999; South Africa, 2003a; South Africa, 2003b; South Africa, 2000).

PPPs at the national and provincial level are governed by Sections 31(1)(a)(iii), 51(1)(a)(iii) and 76(4)(c) of the Public Finance Management Act and Treasury Regulation 16. PPPs at the municipal level are governed by the Municipal Finance Management Act and Regulations, and the Municipal Systems Act (South Africa, 2007). Against this background, the National Treasury states that all these statutory and regulatory frameworks are aimed at ensuring that the South African government delivers infrastructure and public services without violating its constitutional mandate (South Africa, 2004).

4.9 History of public-private partnerships in South Africa

Like other developing countries, South Africa joined other nations around the world by utilising PPPs as an integral strategy to deal with infrastructure backlogs and deficiencies, and to further address socio-economic, societal, and political problems (Chisa, Ayode, Ikeni & Gambo, 2015). So far, the South African government has adopted the use of PPPs to achieve national and international plans, such as the Millennium Development Goals (MDG); the National Development Plan (NDP); and the Accelerated and Shared Growth Initiative for South Africa (Asgisa) (Fombad, 2019).

PPPs in South Africa have been in use since 1999 and are regulated through the Public Finance Management Act, Act 1 of 1999 (PFMA) and Treasury Regulations (TR) 16, which govern municipal PPPs under the Municipal Finance Management Act, Act 56 of 2003 (MFMA). These legal instruments provide a clear and transparent framework for the government and its private sector partners to enter mutually beneficial commercial transactions for the benefit of the public (South Africa, 2007). Against this background, the South African government has increased the number of PPP transactions in several sectors, such as transport, office accommodation, healthcare, eco-tourism, social development, and correctional services (Jomo, Chowdhury, Sharma & Platz, 2016; Mathonsi, 2012).

Ngamlana (2009) proposes that there are two types of PPPs in South Africa, guided by the South African regulatory framework on PPPs. They consist of PPP projects in which a private party performs an institutional function, also referred to as institutional PPPs; and projects in which a private party acquires the use of state property for its own commercial purposes, this is referred to as contractual PPPs. These projects are usually funded through a combination of equity, debt and, in some instances, government capital contributions. Against this background, the 2018/19 budget report by the National Treasury indicated that 33 PPP projects, at a value of R89.3 billion, had been undertaken and completed since 1999, when PPPs were first incepted in South Africa.

In addition, of the R834.1 billion planned for public sector infrastructure spending over the next three years, PPP projects accounted for R18.5 billion, which amounted to 2.2 percent of the total public-sector infrastructure budget estimate (South Africa, 2019). As with international trends, the various types of projects undertaken in South Africa based on contractual arrangements involved DFBOT projects; DFO projects; DBOT projects; equity partnership projects; and facilities management projects (National Treasury, 2019). Below is an overview of completed and operational PPPs in South Africa. The discussion provides a brief overview of some of the PPP projects that have been concluded and are in operation in the country.

4.9.1 Road infrastructure

In 1996, the South African government together with the Mozambican government entered a 30-year concession contract worth R3 billion for a private consortium, Trans African Concessions (TRAC), to build and operate the N4 toll road from Witbank, South Africa to Maputo, Mozambique. The control and management of the road will revert to the two governments on completion of the 30-year period. Apart from the financing of the project by TRAC, both the South African government and the Mozambican government provided a guarantee of the debt provided that certain conditions were met (National Treasury, 2007).

4.9.2 Recreational parks

In 2001, a BOT concession was signed by the South African National Parks (SANParks) and Nature's Group, a consortium formed to outsource the management of 11 restaurants, two shops and three picnic spots in the Kruger National Park (KNP) Game Reserve for a period of ten years. The consortium was given the right to operate the facilities, including the right to use, design and construct the facilities in accordance with parameters provided by SANParks. Nature's Group would in return pay a monthly concession fee amounting to 13% of its turnover to SANParks (National Treasury, 2007).

4.9.3 Rail transport

The Gautrain Rapid Rail Link (GRRL), commonly known as the Gautrain, was another large infrastructure project delivered through a PPP in South Africa. In 2006, the Gauteng Provincial Government signed a 20-year PPP contract with the Bombela Concession Company to design, build, part-finance and operate the Gautrain. The control and management of the Gautrain will revert to the Gauteng Provincial Government after a 20-year period. This is the biggest PPP in Africa and the largest rapid rail link infrastructure project on the African continent, worth R25 billion (Flyvbjerg, 2007; National Treasury, 2007).

4.9.4 Correctional facilities

In order to address the significant shortage of correctional facilities, the South African government in 2000, through the Department of Public Works and the Department of Correctional Services, signed 25-year BOT concessions for maximum-security prisons in Bloemfontein and Louis Trichardt. This was part of the Department of Public Works Asset Procurement and Operating Partnership Systems (National Treasury, 2007). The two winning bidders were mandated to design, build, finance, operate and transfer the prisons over a period of 25 years. The two facilities hold 3000 inmates each and were operational less than two years after the contracts were signed. The Bloemfontein facility cost R1.7 billion and the Louis Trichardt facility R1.8 billion (National Treasury, 2007).

4.9.5 Hospitals

In the early 1980s, the KwaZulu-Natal government considered building a sophisticated modern 1000-bed teaching hospital in the Cato Manor suburb of Durban (Haarfoff, 2008). However, after the first democratic elections in 1994, the initial idea of building a modern medical institution changed into the construction of an 850-bed referral hospital called Inkosi Albert Luthuli Central Hospital (IALCH) (National Treasury, 2007). This project gained momentum in 1996 through the then KwaZulu-Natal MEC for Health, Dr Zweli Mkhize, and the former KwaZulu-Natal Department of Health Head of Department, Prof. Green-Thompson, who believed that KwaZulu-Natal needed a central medical facility that would serve as a centre of excellence (Jokozela, 2012).

The hospital was the first to be constructed under a PPP. It was regarded as an African PPP and the Health care Deal of the Year in 2002 by *Project Finance Magazine*. The hospital is further regarded as one of the most sophisticated modern hospitals in the world (Leeman, 2002; USAID, 2005). The main objectives of the construction of the IALCH were to increase value for money by selecting the services based on whole life cost; to make service payments based on availability; to ensure that expenditure was within the province's capacity; to establish a replacement programme for all

equipment; and to transfer appropriate risk to the private party (National Treasury, 2007).

4.10 Overview of public-private partnerships in the security sector

The provision of national security or domestic policing services has typically been a function of states. This has been and continues to be more relevant in modern liberal capitalist societies where states have been tasked to carry out duties of providing security to their citizens and protecting their borders and critical interests. However, since the end of the Cold War, there has been a fundamental shift away from the liberal norm where the provision of security through private military and security contractors has gained popularity globally. To this end, the international arena is experiencing an increase in the number of private security and military companies rendering services in the international stage. Private security and military companies undertake a variety of activities that would have traditionally been performed by state security institutions. Such activities include security services; crime prevention services; military operational support; logistical support; and military advice. Moreover, some private companies have also developed in-house analytical capabilities for intelligence and security operations or as an alternative, subscribed to specialist intelligence and analytical providers. They also have an operations or crisis centre and are in possession of considerable amount of data that might be beneficial to governments during and after incidents. This is made possible by the greater advantage and visibility they have on developments in the international domestic arena, which might have an impact on their commercial operations (Abrahamsen & Williams, 2011; Avant, 2005; Gwatiwa, 2016; Kinsey, 2006).

Considering the above, the US, the UK, Angola, South Africa, Canada, and Nigeria have embraced the use of private security companies and PPPs for a variety of military and security related functions (Kinsey, 2006). For example, in the US, the US Department of Homeland Security (DHS) through its Science and Technology Directorate (S&TD) have initiated an innovative and commercially based PPP project named the System Efficacy through Commercialization, Utilization, Relevance and Evaluation (SECURE™) Program. The Program is aimed at leveraging the DHS resources, experience, and expertise to develop and deliver fully deployable solutions

aligned to the detailed operational needs of the DHS and other stakeholders. Through this initiative, DHS stakeholders such as the Federal Emergency Management Agency (FEMA); Transportation Security Administration (TSA); US Customs and Border Protection (CBP); Secret Services (SS); Immigration and Customs Enforcement (ICE); United States Citizenship and Immigration Services (USCIS); the Coast Guard; local police; the fire department; hospitals; rescue teams; and other critical infrastructure and key resources owners and operators are provided with mission critical capabilities that enable them to perform their jobs effectively and efficiently. Key to the development of the SECURE Program was the need by the US DHS to address various requests for assistance from its various stakeholders and to find better ways of solving the varying problems of stakeholders. Thus, the varying requests of these stakeholders are collected and presented in what is termed the Commercialization Operational Requirements Document (C-ORD). Thereafter and where appropriate, approved products are posted online to enable potential solution providers or vendors to apply for participation in the SECURE Program. This process allows for transparency and a more competitive way for multiple providers and vendors to offer potential solutions to identified problems, as outlined in a published C-ORD (Cellucci, 2010; Cellucci & Grove, 2011).

In addition, the United States Agency for International Development (USAID) and the Department of State (DoS) have contracted private militaries and security companies to manage a variety of security risks. These security corporations undertake a variety of duties that are ordinarily performed by members of the military, including the protection of key personnel, convoys, and sites. The involvement of private military and security companies has been fueled by a reduction in troop numbers and the environment, which favours the privatisation of such components of security services. The use of private military and security companies by the US in countries such as Iraq and Afghanistan have offered a pathway to achieve political, tactical, operational, and strategic objectives during counterinsurgency operations. It is estimated that in 2010, 30 479 contractors were contracted by the US Department of Defence in Iraq and Afghanistan. Moreover, the DoS and USAID had contracted an estimated 1850 and 3770 security contractors in Afghanistan (Bellens, 2019; Schwartz, 2011;).

As indicated earlier, countries in Africa, such as Angola, Sierra Leone and South Africa also have experience of utilising private militaries and security companies to render a

variety of security service to these governments and private corporations. The reliance on private armies to render a variety of military functions has been catalysed by shrinking budgets due to structural reforms and the withdrawal of Western support to African governments. This development was, however, not without contention as the involvement of private militaries and security corporations in Africa has meant different things to different persons. Private military and security companies are regarded by some as valuable actors in the quest for peace and stability on the African continent (Shearer, 1999; Selber & Jobarteh, 2002).

On the other hand, they are contributors to the ongoing conflict in Africa. As an example, the abundance of mineral resources in Sierra Leone, which is the largest producer of diamonds and holds significant reserves of bauxite and rutile, has been regarded as the cause of conflict in that country. This saw the contracting of private military companies, such as Executive Outcomes (EO), a private military company based in South Africa, to provide military personnel, equipment, training and other military assistance to the government of Sierra Leone. It is said that the presence of EO changed the tide of war in favour of the government of Sierra Leone, with the government being able to regain control of most of the mining areas in the country. This development highlighted the significant influence that the private sector has on national security operations in countries that make use of such services (Shearer, 1999; Selber & Jobarteh, 2002).

Although South Africa did not see the emergence of private militaries with the advent of democracy in 1994, it has seen an exponential growth in private security companies rendering services to both the government and private corporations over the years. This was driven by the inability of the state to police certain activities and the expanding public demand for crime prevention and security services. The demobilisation and reintegration efforts of former security personnel of the apartheid government who took voluntary retrenchment packages as a result of transformation processes and the withdrawal of the police service from other policing precincts to focus more on policing political conflicts in the townships during political uprising also created a vacuum that needed to be filled by private security companies for the purpose of crime prevention and protecting private interests. Moreover, the public perception that the police have become ineffective and unable to combat crime also contributed to the

increase in contracting private security companies and employing more sophisticated security technologies and self-protection measures. This was most notable in the more affluent white suburbs and shopping malls, more so than in the townships in South Africa. The oversupply of readily available persons with military and security background who were retrenched and those who were unable to be retained by various state security institutions during the transition to democracy in 1994 contributed significantly to this phenomenon (Minnaar & Ngoveni, 2004; Minnaar, 2005). This, however, did not remain without contention, as the ability of the private sector to take over what has traditionally been a police function remained a debatable point. Besides, should the private security industry be allowed to take over functions that traditionally were performed by the police, which have the potential to bring about mutually beneficial outcomes? Should there not be some form of regulation to ensure a more efficient and effective functioning of the public-private interface on security operations? Against this background, the South African government took a harsh stance against the functioning of private militaries in armed conflicts, and it has regulated the functioning of private security companies in the country. The enactment of the Prohibition of Mercenary Activities and Regulation of Certain Activities in the Country of Armed Conflict Act, Act 27 of 2006, and the Private Security Industry Regulatory Act, Act 56 of 2001, also known as the PMA and the PSIRA Act respectively, were seen a method of regulating the existence of private armies and security companies.

The involvement of the private security industry in South Africa has seen mixed results in that the presence of the private sector in security activities has been a crucial resource in combating crime. In this context, the private security industry has been regarded as more effective and efficient than the police in combating crime in South Africa, as it has the necessary equipment and resources to combat crime. The involvement of the private security sector in the provision of security services also encourages the transfer of skills and when employed abroad, it allows for the indirect gathering of intelligence. On the other hand, dependency on the private sector is likely to breed state complacency. Furthermore, should profit margins decline, the private sector is likely to withdraw and leave an undesirable vacuum in the security architecture (Taljaard, 2008; Bosch & Maritz, 2011; Gumedze, 2015; Berg & Howell, 2017).

With the private sector playing a significant role in the provision of security and crime prevention services in other countries and in South Africa, it is also acknowledged that the task of securing any country's borders appears to be an extensive and daunting operation that cannot be accomplished by the government alone. Therefore, like with other public infrastructure, services and security projects, effective collaboration in the form of public-private partnerships becomes essential in addressing border security challenges worldwide (Carter, 2008; Busch & Givens, 2012). This aspect is also relevant in the South African border environment, particularly where there is increasing global recognition that PPPs play a key role in ensuring effective border security. Regrettably, there is an absence of, or where present, minimal scholarly research on the opportunities and challenges of fostering PPPs partnerships to enhance border security in South Africa. There is also a lack of recognition of the important role that the private sector could play in enhancing border security in South Africa. This is perhaps caused by a void between business and national security agencies when it comes to appreciating each other's capabilities and limitations, and the reluctance to deviate from traditional norms of providing border security exclusively through state security agencies (Gadda & Patil, 2013; Motlagh, Bagaa & Taleb, 2017; Liu, Liu, Shi, Wu & Chen, 2019).

Considering the above argument, the current situation in the South African border environment renders it essential for the government to explore alternative means of providing effective border security. Thus, the employment of solid partnerships between the state and private sector could be of value in enhancing border security in South Africa, and as mentioned by Kawakubo (2017), the state on its own cannot manage emerging security challenges such as organised crime. In support, Busch and Given (2012) emphasise the growing role of PPPs in homeland security matters and further comment that PPPs can enhance issues such as resource utilisation, specialisation, and technological innovation. Similar sentiments are held by Clark et al. (2006) when they state that although it is acknowledged that the state plays a central role on issues of homeland security, the provision of greater homeland security could be enhanced through significant participation by national and local governments, and the private sector. PPPs have also been embraced as being the best approach to meet the challenges of other national security programmes, such as cyber security, by enabling greater cooperation between the private and public sectors to meet shared

challenges. The literature regards cyber security as a public good; as such, the adoption of PPPs as a method of providing cyber security is gaining recognition in liberal democracies (Dunn & Cavelty, 2014; Carr, 2016; McCarty, 2018).

4.11 Public-private partnerships in space technology projects

The adoption of PPPs in space technology projects did not become relevant until the late 1990s, when the USA and Europe made efforts to build close partnerships between the public and private space sectors. However, the participation of the private sector was limited because of the huge risks associated with space projects. In the 1980s, Europe established a joint venture of national space agencies and space industries in what was termed the Arianespace. This resulted in the commercial launch of the European-made Ariane launch vehicle, where the responsibility of the private partner was limited to the operational phase of the project. During the same period, the US government also attempted to privatise the Landsat program, which was the US's land remote sensing satellite capability. However, this was reduced to the transfer of operations to a private party (Harvey, 2003).

Against this background, the space industry has continued to mirror other sectors of the economy by introducing PPPs in several space applications, such as remote sensing, global navigation, international communication systems, spaceports and space solar power systems. Through this approach, the expectation of various governments was that the expanded participation of the private sector would enhance the efficiencies of the space programmes and further foster the competitive domestic space industry (Howard, 2008). Moreover, Morse (2017) asserts that research in the space science industry provides unlimited potential for tackling thoughtful questions about the existence of human and other species and for opening the doors of exploration, innovation, and future economic opportunities. The author (2017) further states that space science continues to generate extraordinary discoveries through the exploration of Mars, as an example, the investigation of the essential physics of the universe, or through the discovery of new exoplanets around nearby stars. Thus, the quest for the exploration of space has resulted in the emergence of new companies and greater innovations by traditional aerospace companies to reform the way in which spacecraft are designed, built, launched and operated. In response to this development, there has

been a surge in private sector investment on resources dedicated for creating new commercial space capabilities and initiating the next wave of space exploration. It is also commendable to note that NASA is leaning more towards the integration of commercial space capabilities for the implementation of space science missions, particularly for CubeSats and small satellites. In order to full realise this, it is imperative that NASA continues to embrace a variety of commercial capabilities such as optical sensors, spacecraft buses, and sensors. These capabilities are emerging in the small satellite market, which could be worth $20 billion a year in the next few years. To this end, NASA has announced 19 partnerships with US-based businesses to achieve some of its goals and to encourage the participation of the private sector in space projects (Klotz, 2017; Morse, 2017; Russell, 2017).

PPPs have also entered strategic sectors, such as the military. This was initially seen in two PPP projects that were initiated in the UK and the European Union (EU), namely the Skynet 5 project, initiated in 2003, and the Galileo concession. The Skynet 5 project was conceived as a result of the need to develop a military communication system that would replace the Skynet 4 satellites. The UK government opted for a PPP, as it was believed that it would save the government £500m over the lifetime of the contract (Chuter, 2007; Betran & Vidal, 2005; Iron & Davidian, 2008). This was a 15-year DBFOO concession contract awarded to Paradigm Secure Communication Ltd to deliver a critical military communication satellite with the ability to use additional space for commercial purposes involving a third party. The process involved taking over the Skynet 4 and incorporating it in the proposed two new Skynet 5 satellites and the refurbishment of the associated ground segment, starting in 2005, with the expected full-scale service available in 2008.

The EU selected a 20-year PPP scheme to deploy and operate the Galileo project to meet the public sector's objectives. Unlike the US's GPS, which was designed mainly for military application, this global navigation satellite system project has been regarded as Europe's major public infrastructure project offering numerous advantages for civilian users worldwide. This project resulted from the European Commission decision to investigate the possibility of developing a Global Navigation Satellite System (GNSS) in collaboration with the European Space Agency. These PPP projects have brought about a business-like approach of developing and operating what

traditionally has not been a business-driven operation. Moreover, this approach sought to optimise procurement efficiency and to minimise the public sector's exposure to risks. Thus, the involvement of private investment would reduce the need for the public sector to make significant financial contributions to the project. Furthermore, this approach was expected to reduce the total life-cycle costs by benefiting extensively from the private sector's management skills. Despite its successful launch, the European Commission took a decision to abandon the original plan of substantial participation by the private sector due to liability concerns (Giemulla & Heinrich, 2007).

In another military-related PPP project, the US Department of Defence partnered with a space company, Intelsat Ltd, and Cisco Systems to develop and introduce high-speed internet access to various military units across the country, which were not tied to any location. In this PPP arrangement, initial funding for this project was achieved through private investment and private equity funding. It was further expected that the US military would make future commitments to support new acquisition procedures and future technologies. Furthermore, it was also envisaged that the technological application would be incorporated into an Intelsat, which was under construction at the time of concluding the partnership. The project included government funding for testing and evaluating, although allowing the military to test new hardware for a portion of the total cost of the project should the project be regarded as a purely military endeavour (Pasztor, 2008).

Other examples of satellite projects for military and civil operations that have drawn the attention of the public-private sectors include the COSMO-SkyMed, TerraSAR-X, RADARSAT-2, and Skynet. COSMO-SkyMed, which was jointly developed by the Italian and French governments as a programme of the Italian space agency and the Italian Ministry of Defence, consisted of four satellites, planned for dual-use in military and civil earth observation system. TerraSAR-X is a German radar satellite, which is the product of a partnership between the German Aerospace Center and Astrium GmbH. This partnership aimed to provide data for scientific research and applications and for the establishment of a commercial earth observation market (Werninghaus, 2004; Geoimage, 2020; During, Fifame, Koudogbo & Weber, 2008).

Given the various constraints experienced by border security agencies in South Africa and their inability to render an effective border security service, there is a dire need to consider alternative methods of rendering this important security function. The application of space technology is regarded as one such alternative method. The need to employ space technology to enhance border security in South Africa primarily arises because of physical and human resource constraints experienced by security agencies employed in the border environment to monitor and control the land borders. This is further fuelled by the vastness of South Africa's land borders and the absence of physical barriers along the land borders; variations in the land border terrain; and poor coordination among border security authorities. These operational realities render it difficult for the authorities to control and monitor the South African borders using conventional methods such as vehicle and foot patrols. Moreover, illegal border crossings; transnational crimes; human trafficking and smuggling; poaching of wild animals; and farm attacks have become prevalent in South Africa. This sad reality also makes it necessary for border security and law enforcement authorities to introduce alternative measures of preventing, detecting, and combating these crimes (Baker, 2009; Business Live, 2016; Heitman, 2014; Martin, 2018).

In the African context, advanced countries such as South Africa, Nigeria, Egypt, Morocco, and Algeria have the capability to undertake a variety of space projects. Each of these African countries has a national space agency and has some form of space policy to guide the implementation of their space projects. Egypt is a leading African country in the number of space projects, followed by South Africa (Dahir, 2018; Scatteia, Frayling & Atie, 2020). South Africa, like other developed countries, relies on several organisations including private companies, academic institutions, science councils, and research-based institutions, which can design and develop space technologies. These institutions include Sunspace, Cape Peninsula University of Technology, and the University of Stellenbosch. Thus, the infrastructure and skilled workforce from all these institutions and other institutions allows South Africa to better position itself as a hub of space science and technology on the African continent. This also allows South Africa to strengthen its ties with the space industries in developed spacefaring countries on the African continent. Moreover, as opposed to other African countries that buy satellites and then launch them, South Africa can develop and manufacturing its own satellites, such as in the case of Sunsat, Sumbandila and

Tshepiso, through effective collaboration with academic institutions and space companies (PMG, 2017; South Africa, 2020; Wood & Weigel, 2012).

Another space project, which saw the collaboration of several actors across various industries, was the construction of the Karoo Array Telescope (MeerKAT), the predecessor for the Square Kilometre Array (SKA) in the Northern Cape Province. The development of the SKA , which is the largest radio telescope in the world, saw the involvement of a consortium of 100 organisations from 20 countries. It was reported that South Africa spent R1.2 billion to fund the SKA project, including MeerKAT. Another collaborator in space projects is Denel's Spaceteq, which is a subsidiary of Denel Dynamics, which is entirely owned by the South African government. Spaceteq can develop complete satellites, components, control systems and software. Leading private sector companies, such as the Cape SCS Aerospace Group, which is a corporation of four of South Africa's major space companies – NewSpace Systems, the Space Advisory Company, SCS Space and Space4Development – has provided space technology products and services to 19 countries on five continents (Denner, 2018; Ibeh, 2018; Spaceteq, 2020).

In addition, the private space technology sector in Africa in the field of remote sensing and geospatial technology has increased its involvement in addressing Africa's policy, scientific and practical challenges during the past 20 years. About 50 percent of these companies are situated in countries like South Africa, Nigeria, Kenya, and Ethiopia. International private space technology companies are also collaborating or using the expertise of local companies to expand their market in Africa and to develop capacity-building facilities, which they can use together (Spacewatch Africa, 2018).

Chumba, Okoth and Were (2016) mention that the development of effective space technology for border security in Kenya and Somalia requires both governments to fund and support the development of the required security technologies in order to achieve the objectives of border surveillance and control. Thus, the development of superior border security technology would not only require funding, but also require collaborations in providing additional resources, and the most suitable means would be the involvement of the private sector. This approach would not only save resources for these two governments but would further allow the private sector to use its

knowledge, skills and creativity to develop border infrastructure that is also commerce friendly (Chumba et al., 2016).

In view of all these arguments, there is a global recognition of the employment of various space technology products to enhance border security. The main objectives of space technology would be to optimise border surveillance and control, for intelligence gathering, for the verification of information, and to facilitate easy access to thinly populated regions (Kawakubo, 2017; Pedrozo, 2017; Union Public Service Commission, 2019). Against this background, and as discussed and illustrated earlier in this study, the private sector possesses the necessary capability and is better positioned to provide technology, products, and services solutions necessary for enhancing border security through the application of space technology. Therefore, the employment of space technology through effective PPPs could provide an operational advantage that would significantly enhance the efficiency and effectiveness of border security in South Africa (Anderson, 2008). Moreover, the US has considered the implementation of PPPs for drones. The US government through its Federal Aviation Administration (FDA) has announced that it will collaborate with the private drone industry to support the drone safety integration network, with the participant partners making a pledge of $6 million. The envisaged partnership has the potential to deliver several benefits, including the safe and efficient integration of drones, which in turn will provide the private drone industry with the opportunity to gain valuable experience related to drone technology. Moreover, collaboration between the government and the private sector will ensure that collective efforts are undertaken to resolve difficult technical and operational challenges (Thompson Hine, 2017; Corner Alliance, 2020). Washington (2018) further states that governments across the world should make efforts to partner with the private sector for developing drone technology. The author (2018) referred to organisations, such as Lockheed Martin, Northrup Grumman, and Boeing, who are leaders in drone development for military purposes. Moreover, other smaller companies such as Parrot, Matternet, Zipline and GoPro are also developing and implementing drone solutions in many countries that leverage small drones to solve current societal problems. Thus, partnerships consisting of government agencies, universities and researchers should be implemented to focus on efforts to resolve humanitarian, environmental and wildlife challenges. Such partnerships will be of

great value in helping to drive innovation in drone development and usage in each of the aforementioned areas.

In addition, the US DHS is in partnership with hi-tech industry, CBP, and DHS Science and Technology to enhance the situational awareness of border guards, whose work requires of them to operate in harsh terrains and under extreme physical conditions, supported by tactical headquarters situated far away. This has resulted in the formulation of successful partnerships with hi-tech industries, such as UAV industries (Wilson, 2018). Although PPP projects have entered the space technology sector, they have not been without challenges. Some challenges, which are also common with traditional approaches to PPPs, relate to schedule delays and cost increases. However, there are other unique challenges related to space PPP projects, such as high revenue risk and conflicts of interest. Even though the aforementioned space PPP projects were originally expected to result in high efficiencies, they did not meet the expectancies of high efficiencies and suffered massive inefficiencies. As a result, these PPP projects were forced to restructure their partnership framework in the direction of a more traditional approach. This has resulted in the public sector being more skeptical about the application of PPP approaches in space projects. Moreover, these challenges imply that there are valuable lessons to be learnt about mechanisms of cooperation between the public and private sector partners, which might be useful in better understanding how challenges arising in space-related PPP projects could be anticipated and handled (Hashimoto, 2009; Iron & Davidian, 2018; Morse, 2017).

4.12 Chapter summary

Discussions in this chapter confirmed that many countries in pursue of development were considering private investments through public-private schemes to achieve their developmental goals and needs. One factor that encourages partnerships between the public and private sectors is that the schemes provide for a new and dynamic way of financing the provision and delivery of public infrastructure and services. In this regard, the private sector can bring a variety of strengths, skills, resources and capabilities to PPP projects. Furthermore, the private sector is said to be better positioned to contain the risks that come with mega infrastructure projects. Moreover, it is acknowledged that PPPs provide a variety of benefits for societies in the form of

enhanced government capacity, cost reductions, and efficiency in the delivery of projects. It is also believed that PPPs hold a variety of benefits for societies, such as an enhanced public sector capacity and innovation. PPPs have been used to provide a variety of public infrastructure projects, such as roads, housing, hospitals, electricity, and educational facilities. PPPs have also entered strategic sectors such as the military, policing, and the space sector.

Although PPPs have been embraced by several countries, including South Africa, as the preferred alternative method of delivering public infrastructure and services, they are not without challenges. PPP projects face challenges such as schedule delays and increased operating costs. These aspects require parties contracting to PPP schemes to concern themselves with issues of transparency, competitiveness during the bidding process, the equitable distribution of risks, and adequate government guarantees. Despite these challenges, budgetary constraints faced by the public sector compel it to depend on the private sector for investment and participation in delivering major public infrastructure projects and essential services. Hence, PPPs remain a critical scheme in pursuing major and essential public infrastructure projects and services, which cannot be best delivered by the public sector or the private sector acting on their own.

CHAPTER 5

RESEARCH METHODOLOGY

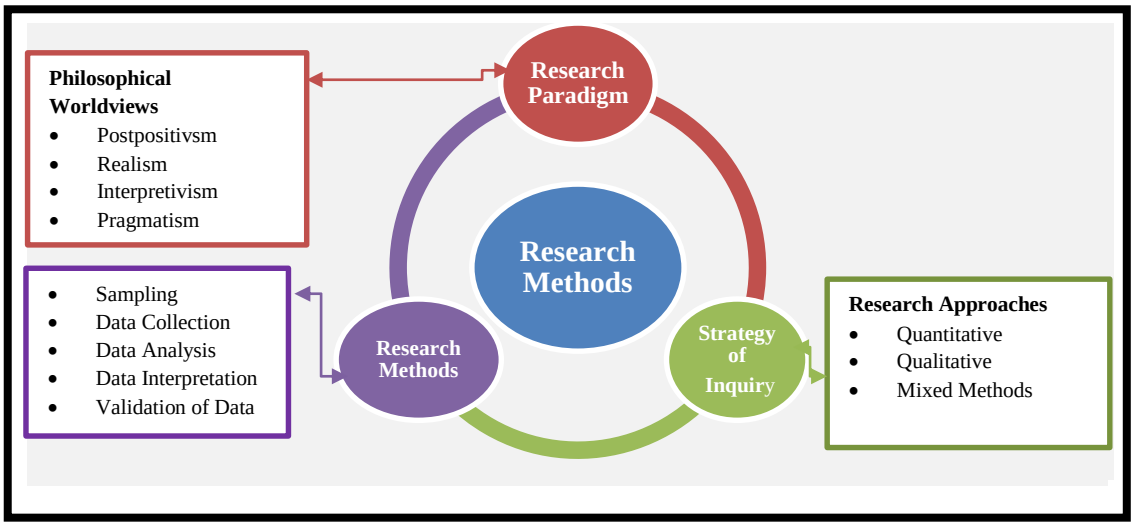
5.1 Introduction

Research often arises out of humankind's curiosity to understand social and natural issues that surround them. Historically, scientists and philosophers have developed and considered various approaches and practices to study and understand the complexity of the philosophical and natural phenomenon of humankind. These approaches continue to play a critical role in shaping the existence of humankind and the efforts undertaken by researchers to try to understand reality (Al-Busaidi, 2008). Given this, for any research to be valuable and have the potential to contribute to the existing body of knowledge and provide solutions to existing social and natural problems, accepted methods of enquiry must be adhered to. This consists of following the accepted rules of research, which are intended to minimise any undue personal, social, or other unreasonable influence on the research results.

Given the above, this chapter seeks to provide an overview of the research process followed by the researcher during this study. It also provides reasons for selecting the qualitative research method. Thus, this chapter details the methodology concepts and the research methodology applied by the researcher. The contents of this chapter include the nature of the research approach and design, the methods of data collection, the data analysis procedures, and the methods used to ensure the trustworthiness and quality of the research. This chapter concludes with an overview of the ethical framework within which the research was conducted.

Figure 5.1 depicts the research design elements applicable to this study. The chapter begins with a brief discussion of the philosophical worldviews that underpin any research and this research. This chapter further discusses the research design and approach, and the research methods. All of these will be discussed in more detail in the sections to follow.

Figure 5.1: Research design elements



Source: Adapted from Creswell (2014)

5.2 Philosophical worldviews

While planning for a study, the researcher should think thoroughly about the philosophical worldview that underpins the said study; reflect on the research design commensurate to the specific worldview; and ultimately adopt specific methods and procedures of enquiry that translate the identified approach into practice (Creswell, 2009). Creswell (2014) explains that worldviews arise from several factors including discipline orientation; previous research experience; and the research supervisor's inclinations. All these factors will determine which approach the researcher will adopt when conducting the research, be it quantitative, qualitative or a mixed method approach.

Several worldviews exist; however, Creswell and Clark (2007) suggest that there is no standard explanation for what they might be. The different worldviews that a researcher could apply are the postpositivism approach, which is also known as the scientific method: the constructivist theory, referred to as social constructivism; the transformative worldview; and pragmatism, which are all summarised in Table 5.1 (Creswell & Clark, 2007; Creswell, 2014).

Table 5.1 : The four worldviews

Postpositivism	**Constructivism**
• Determination • Reductionism • Empirical observation and measurement • Theory verification	• Understanding • Multiple participants meaning • Social and historical construction • Theory generation
Transformative	**Pragmatism**
• Political • Power and justice oriented • Collaborative • Change oriented	• Consequences of action • Problem-centred • Pluralistic • Real world practice oriented

Source: Creswell (2014)

Before deciding on the research philosophy and paradigm to be used for this research, it became imperative for the researcher to consider the different types of research philosophies applicable to research, as discussed briefly in the sections to follow.

5.2.1 Postpositivism

The postpositivism worldview, also known as empirical science or the scientific method, represents the traditional form of research and is more relevant in quantitative research than in qualitative research. The postpositivism assumption is rooted in the notion that causes usually determine effects or outcomes. Thus, researchers who follow this worldview seek to understand the causes of a particular effect or outcome. Moreover, this worldview is reductionist in nature as it seeks to break down bigger pieces into smaller pieces to formulate a hypothesis (Creswell, 2014).

The postpositivism assumption produces knowledge that is based on the careful measurement and observation of real-life activity using instruments that are independent of the researcher and the instruments used by the researcher. This assumption is also based on the notion that there are laws that govern the world, and

these laws need to be tested so that the world can be understood (Creswell, 2014; Henning, Van Rensburg & Smit, 2004).

Walsham (1995) suggest that postpositivism holds the view that scientific knowledge comprises of facts, whilst its ontology considers reality as independent of social construction. Thus, the principles of postpositivism are mainly dependent on quantifiable observations that ultimately lead to statistical analysis of the setting being studied (Schrage, 1992; Yin, 2006). As opposed to phenomenology, postpositivism emphasises the view that a researcher needs to concentrate on facts rather than on the meaning participants attach to the social setting and their varying interests. Thus, postpositivism is the most suitable approach when studying the nature of relationships between two elements (Henderson, 2011).

5.2.2 Constructivism

Constructivists hold the view that the existence of knowledge and truth is through human beings and these factors do not exist outside the human mind (Duffy & Jonassen, 1991). Similar sentiments are held by Lapan, Quartaroli and Riemer (2012) and Bloomberg and Volpe (2008) when they argue that key to constructivism is the assumption that reality is a social construction developed by individuals through the subjective meaning they attach to the world and the meanings they attach to their own personal experiences. These occurrences provide for various meanings to be conveyed to humans in different settings consisting of social, historical, and cultural contexts within which the lives of humans are embedded. According to Cooperstein and Kocevar-Weidinger (2004), the constructivist approach prescribes that the concept follows the action and not the other way around. These authors (2004) further state that activity leads to the concepts, as opposed to the view that concepts lead to activity.

Crotty (1998) suggests that there are generally accepted characteristics of constructivism, consisting of the notion that humans attach their own meaning to their life experiences. Moreover, humans are not passive beings; they tend to try to make sense of information at their disposal. Humans also tend to be manipulative, and they often discover and create knowledge to fit their own belief systems. Another agreed upon characteristic of constructivism is that new learning is built upon existing

knowledge, and to make sense of information at their disposal, humans make connections between existing knowledge and emerging information. Moreover, leaning is a social activity always generated because of interaction with a human community. The constructivist process is thus more suitable in a social setting due to the opportunity provided to humans to compare and share their experiences and ideas with others.

A key characteristic of constructivism is the aspect of interaction between the researcher and the object of the investigation, where deeper meaning can only be uncovered through such an interaction (Davis, 2013). Henning, Van Rensburg and Smit (2004) indicate that a phenomenon and an event are better understood through the mental processes of interpretation commonly influenced by the interaction with social context. Thus, the task of the researcher is to analyse text in order to understand the meaning humans attach to their lives. This paradigm requires research participants to be actively involved in the entire research process. The participants become active partners in the entire process as they seek to understand the world they live and work in (De Vos, Strydom, Schulze & Patel in De Vos et al., 2011).

Similar sentiments are held by Creswell (2014), as the author asserts that in the constructivist worldview individuals seek understanding of the world they live and work in. Thus, the objective of research is to understand the participants' comprehension and their personal views of what is being studied. This requires the researcher to ask open-ended questions so that participants, on their own, can construct the meaning of a situation. Moreover, this paradigm allows the researcher to listen carefully to the responses provided by the participants about their life and work setting.

5.2.3 Transformative

The transformative worldview seeks to accommodate marginalised members of society. It is an alternative framework, which differs from the postpositivism framework, which imposes structural laws and theories not commensurate with the needs of marginalised communities. The basis for the transformative framework is to change the lives of marginalised people. Issues facing marginalised communities such as suppression, denomination and sexual orientation are also important to study and in

the process of being studied, the researcher provides a platform for such marginalised individuals or groups to raise their concerns and to improve their lives (Creswell, 2014). Thus, the transformative framework seeks to balance social inequalities by producing credible evidence that speaks to the interests of the marginalised (Mertens & Hesse-Biber, 2013).

5.2.4 Pragmatism

Pragmatism is a problem-oriented method of enquiry, which seeks to provide practical solutions to practical research problems. Pragmatism judges research approaches against the practical outcomes they will yield. Key to the philosophy of pragmatism is the assumption that knowledge is based on practical outcomes and what works. In addition, research should test what works through an empirical enquiry and there is no single method of enquiry that can lead to absolute results. Moreover, something that is known as the truth today might not the truth in future. Considering this, pragmatism does not concern itself with a method of enquiry; it supports the mixed methods approach for as long as such method is useful in addressing the identified problem (Denscombe, 2006; Baranov, 2012).

Creswell (2014) describes the pragmatic worldview as a philosophical underpinning applicable to mixed-methods research, which focuses on research problems in social science research. In this paradigm, pluralistic approaches are used to gain knowledge about the problem at hand. The author (2014) elucidates that pragmatism arises out of actions, situations, and consequences, and instead of focusing on the method of enquiry, emphasis is placed on the research problem and all available approaches are applied to understand that problem. Thus, pragmatism allows for the application of multiple methods of enquiry; the adoption of different worldviews and assumptions; and the use of different forms of data collection and a variety of data analysis methods (Creswell, 2014).

Given the above, the research philosophy, which fits closely with this research, is that of pragmatism. This research is problem-oriented and real-world practice-oriented. The underlying belief that in some cases an absolute truth can be extracted, based on facts, became relevant in this research. Therefore, a qualitative approach consisting of

document analysis and semi-structured interviews was utilised in this research. In this research, the process of document analysis consisted of the collection and analysis of official statements and reports by senior members of the SANDF on aspects related to the study. They consisted of the challenges experienced by the SANDF in controlling and monitoring the borders, common threats, and risks of border security in South Africa, and measures to enhance border security in South Africa. In addition to document analysis, the researcher conducted semi-structured interviews with members of SAPS and subjects' experts in border security and space technology. The questions posed during the semi-structured interviews were open-ended and provided the researcher with an opportunity to follow up on answers provided by the participants. The empirical data collected during the research was instrumental to the understanding of the phenomenon under study and in providing practical solutions to the identified research problem.

5.3 Research design

A research design is a basic plan of research which highlights the strategy; conceptual framework; factors/issues to be studied; and the tools and procedures to be used for collecting and analysing empirical materials (Punch, 2000; Bryman, 2012). The research sought to find practical solutions to the real problems of border security in South Africa. Considering this, the researcher applied pragmatism, which is a problem-oriented method that seeks to provide practical solutions to the problem of ensuring effective border security in South Africa (Denscombe, 2006; Baranov, 2012). Therefore, the researcher applied an empirical research design to address the problem statement; the research aims, the objectives; and the research questions. This was achieved by conducting Key Informant Interviews (KIIs), while using semi-structured interviews with members of SAPS. Moreover, semi-structured interviews were held with specialists in space technology, and senior researchers in space technology and border security.

The initial plan for this research was for members of the SANDF to participate in the study. However, the SANDF rejected the researcher's request to conduct the study in the SANDF. As such, the researcher resorted to the analysis of documentary sources in order to understand the issues and challenges of border security from the perspective

of members of the SANDF. Document analysis is described by Bowen (2009) as a systematic procedure for reviewing or evaluating documentary sources. Documentary sources could be in print or in electronic format. Considering this, the researcher used official government documents consisting mainly of official statements and media briefings by senior members of the SANDF to conduct the document analysis. As described by Denzin (1970), the document analysis process required the researcher to examine and interpret the collected data to elicit meaning and to gain an understating of the phenomenon under scrutiny.

5.4 Research approach

A research approach is a plan and procedure for research aimed at driving it from a general approach to a more detailed method of collecting, analysing and interpreting data. A research approach could be quantitative or quantitative, or both (Creswell, 2014). In this regard, Marshall and Rossman (2006) define qualitative research methods as methods of gathering information by participating in the setting, observing situations directly, interviewing, and analysing documents. In this research, the researcher made use of a qualitative approach by conducting semi-structured interviews with a sample of lead players in the field of border security and space technology.

The researcher also interviewed border security officials consisting of senior members of SAPS involved in border security at selected border areas. Moreover, the researcher conducted a documentary analysis of documents relating to border security in South Africa. This approach allowed the researcher to extract rich and in-depth information from the research participants, as opposed to the quantitative method, which emphasises objectivity through measurements and statistical, mathematical, or numerical analysis of data collected through polls, questionnaires and surveys; or through the manipulation of pre-existing statistical data using computational techniques (Babbie, 2010; Creswell, 2014).

5.5 Research population

Goddard and Melville (1996) and Walliman (2011) define a research population as any group that is the subject of research interest, which could consist of objects, people, or even events. The all-inclusive research population in the border management environment in South Africa would consist of SAPS, the SANDF, the DHA, the DALRRD, the DOH, the Road Traffic Management Corporation (RTMC), and the SSA. The SANDF is tasked with the controlling and monitoring of all the land borders of South Africa. The SAPS is also tasked with the controlling and monitoring of the land borderline within a 10-kilometre radius of any land port of entry. Additionally, the DHA is tasked with controlling and monitoring human migration at all South African ports of entry, and within the boundaries of South Africa. The BMA, which is the newly established component of the DHA, will assume total control of the function of monitoring and safeguarding of the land borders and ports of entry in South Africa.

Since the DHA, through the BMA, is not yet the custodian of border security in South Africa, the researcher decided to exclude members of the DHA from participating in this study. Therefore, the entire population of participants in this research would have been from the SANDF and SAPS. The other state entities play a supporting role in the management of human migration in South Africa and were excluded from participating in this research. Other participants in this research were space technology specialists and subject specialists in border security. Thus, the ideal population would have been all the role players in the space technology industry and all researchers in the field of border security. Another population relevant to this study consisted of documentary sources such as media statements and official reports by the SANDF. These documents were accessed from the Internet. Considering the large amount of documentary sources available on the Internet, the researcher limited the collection of documentary sources to official sources that were not more than five years old and were applicable only to the SANDF's border security operations.

5.6 Target population

A target population can be defined as individuals or groups who the researcher views as being representative of the population under research (Cooper, 1998). A population

can further be defined as any group that is the subject of research interest, which may consist of objects, people, or events (Goddard & Melville, 1996; Walliman, 2011). As such, the SANDF and the SAPS are key role players in border safeguarding, controlling, and monitoring in South Africa. Moreover, institutions, such as the Institute for Security Studies (ISS), are also key role players on matters of research on defence and security. Private entities also play a key role in the development and manufacturing of space technology. For this reason, the researcher conducted semi-structured interviews with senior officials from government institutions responsible for border security in South Africa; senior researchers on border security and space technology; and industry specialists in the field of space technology. The researcher chose these participants as they possess the necessary expertise and knowledge on borderline security matters and space technology.

Due to the SANDF declining the researcher's request to conduct the study in the SANDF, the researcher used official SANDF media reports and statements in this study, which could be considered as the researcher's sample. These documents were mainly acquired from the websites of the Department of Defence (DOD), the Government Communications and Information System (GCIS), and the Parliamentary Monitoring Group (PMG). They consisted of written statements and video recordings.

A total of 36 articles were accessed and analysed by the researcher. The documents chosen were relevant specifically to the SANDF and the research topic, especially on the experiences of the SANDF on border security challenges and measures that could be employed to enhance border security in South Africa. Thus, document analysis was of value in addressing the main themes of border security in South Africa, and the main theme of using space technology to enhance border security in the country. However, the researcher could not obtain SANDF documents, which covered the main theme of PPPs to enhance border security through space technology.

5.7 Sampling frame

A sampling frame defines all the members of the population who are eligible to be included in each sample. A sampling frame is more common in survey sampling (Given, 2008; Lewis-Beck, Bryman, & Liao, 2013). Therefore, the sampling frame in

this research was all senior officials responsible for controlling and monitoring the land borders in South Africa; all officials employed in the space technology industry in South Africa; and all subject specialists in the field of border security in South Africa. Considering the aspect of document analysis, which was affected by the researcher after the SANDF declined the researcher's request to access research participants, the sampling frame for the SANDF for the purpose of document analysis could have been all SANDF official documents, all media reports, and all official statements in both printed and electronic formats. However, due to practical considerations, time, and budgetary constraints it was impossible to involve all the members of the population who were eligible to partake in the research. It was also impossible to gather all official SANDF documents. As such, a sampling strategy was applied to select a representative population, as will be discussed in the next section.

5.8 Sampling strategy

A sampling strategy seeks to provide the researcher with estimates of population parameters from sample statistics for the purpose of decision making (Swanson & Holton, 2005). Against this background, Ritchie and Lewis (2003) state that when sampling strategies are described, a distinction is made between probability and non-probability samples. The authors (2003) further state that qualitative research uses non-probability samples for selecting the population for the research. Therefore, sampling can be defined as a process of selecting a representative part of a population to make generalisation about the whole population (Leedy & Ormod, 2015; Thomson, 2012).

The researcher applied purposive sampling, which is the deliberate search for participants with characteristics in accordance with the needs of the researcher, the developing analysis, and the emerging theory. This sampling method allowed the researcher to select participants with experience and knowledge on border security and space technology (Creswell, 2008; Lewis-Beck et al., 2013). Thus, purposive sampling enabled the researcher to locate participants of interest with the necessary knowledge on border security and space technology so as to best answer the research questions. This was also applied when the researcher was searching for SANDF documents. The researcher focused only on official SANDF documents, which covered the topic of

border security. These documents were derived from official statements and media briefings.

In order to comply with the requirements of purposive sampling, the researcher approached the research units of the SANDF and SAPS to discuss the research topic and seek assistance in obtaining approval to conduct the research, and to further identify officials within the border security management environment who are responsible for border control and monitoring. This process sought to ensure compliance with the inclusion and exclusion criteria. The inclusion and exclusion criteria outline the population that can be included or excluded from the research sample. The inclusion criteria refer to characteristics that the potential participants must have in order to participate in the research. The inclusion criteria seek to select the research population in a more objective, consistent, reliable, and uniform manner. On the other hand, the exclusion criteria consider characteristics that the participants might have that would make them ineligible for the research (Nezu & Nezu, 2008; Salkind, 2010).

5.8.1 Site selection

In research, the process of site selection consists of the identification and justification of a site to locate research participants who will partake in the study (McMillan & Schumacher, 2010). In the South African military context, the border security management function consists of nine regional SANDF Joint Tactical Headquarters (JTACQ). Each of the nine provinces in South Africa has a JTACQ; that is, Limpopo, Gauteng, the Free State, Mpumalanga, North-West, the Northern Cape, the Western Cape, the Eastern Cape, and KwaZulu-Natal (Hennop et al., 2001).

Regional JTACQs are responsible for the operational deployment of various tactical headquarters under their command, such as tactical headquarters assigned for the border safeguarding function. However, the nine regional JTACQs receive their operational instructions from their headquarters in Pretoria, under the command of the Chief of Joint Operations (CJOPS). The CJOPS controls the operational deployment of the SANDF, including the regional JTACQs. The various tactical headquarters also

receive instructions from Defence Intelligence (DI) and the South African Army for force preparation and deployment (Hennop et al., 2001).

Of the nine regional JTACQs, the researcher purposively targeted the regions of Limpopo, the Free State, Mpumalanga, North-West, and KwaZulu-Natal. It was the intention of the researcher to interview senior operational officer from these five regional JTACQs. It is unfortunate that the SANDF declined the researcher's request to conduct the research in the SANDF, citing security concerns.

The border security function also consists of the SAPS border policing precincts, which are situated in various border posts along the borderline, such as the Maseru Bridge, Ficksburg and Van Rooyens Gate border posts in the Free State; Lebombo and Oshoek border post in Mpumalanga; the Beitbridge and Groblersbridge border posts in Limpopo; Kosi Bay and Golela border posts in KwaZulu-Natal; and Ramatlabama and Kopfontein in North-West. These border posts were purposively selected by the researcher for data collection. The border policing function falls under the responsibility of the Divisional Head: Operational Response Services, with the headquarters in Pretoria, South Africa.

Considering the above, the sites in this study were border areas that experienced the most challenges of border security. These border areas were identified through the literature review and through an enquiry with role players in the border security environment. As such, the researcher identified the South Africa-Zimbabwe, South Africa-Mozambique, South Africa-Lesotho, and South Africa-Swaziland border areas as the most problematic border areas. Therefore, the researcher requested permission from the SANDF to interview participants in all nine regional JTACQs.

The researcher also requested permission from the SAPS to interview key participants from the selected areas of operation, consisting of SAPS Unit Commanders at border posts in Mpumalanga (Lebombo and Oshoek); Limpopo (Beitbridge and Groblersbridge); the Free State (Maseru Bridge, Van Rooyens Gate and Ficksburg Bridge); KwaZulu-Natal (Kosi Bay and Golela); and the Northwest (Ramatlabama and Kopfontein). SAPS approved the researcher's request to conduct the research at the identified ports of entry.

Due to the inability to access SANDF participants, the researcher decided to select SANDF official documents consisting of official reports, statements, media briefings and media statements, which highlight the issues and challenges of controlling and monitoring South Africa's borders and the proposed measures to enhance the effectiveness of border security in the country. These documents were all obtained from the Internet. Thus, the Internet could be regarded as the selected site for this research. This documentary data allowed the researcher to gain a clear understanding of the issues and challenges of border security in South Africa.

5.8.2 Participant selection

The participants in this study were senior border security officials responsible for managing and coordinating border security activities. The participants were selected from the key departments responsible for the management, coordination, and execution of border security activities in South Africa. The researcher did not focus only on one department but sought to identify and select departments that have a dominant presence in the border environmental and that have been assigned to coordinate border security activities.

The first criteria were to identify a senior official, whom according to the researcher's criteria, would be considered as any official who had been assigned the task of executing the border security function. It would be an official with the rank of a Captain in the SANDF and SAPS.

Other participants included subject specialists in the field of border security and space technology. These consisted of researchers, advisors and specialists. Officials from the SANDF did not take part in the study because the SANDF declined the researcher's request to conduct the research in the SANDF. Given this, **Table 5.2** depicts the initial sample size the researcher intended to interview and the number of actual participants who took part in the study.

Table 5.2: Sampling

Institution	Position	Initial Sample Size	Actual Participants
SANDF	Senior Officers	9	0
SAPS	Senior Officers	9	5
Border Security Specialist	Researchers	3	4
Space Technology Agencies	Specialists	3	5

5.9 Qualitative data collection methods

Qualitative research does not concern itself with making generalisations about the research concerned but seeks to gain an in-depth understanding of the phenomenon under study. Qualitative research provides for four methods of gathering information. These methods include participating in the setting; observing the participants directly; having in-depth interviews with the participants; and analysing documents and material culture (Marshall & Rossman, 2006). Therefore, in this research the researcher collected research data through semi-structured interviews, document analysis, and the literature review. In compiling the research report the researcher used an integrated approach, where data from the literature, documents and the semi-structured interviews were integrated to gain a better understanding of the research problem and the challenges experienced by border authorities. The study also sought to hear the views of subject specialists to enhance the quality of the research.

5.9.1 Literature review

One of the methods used by the researcher to collect data was through an extensive review of the literature to determine what has been published or written up on border security and the issues and challenges of controlling and monitoring South Africa's borders. According to Creswell (2009) and Welman, Kruger and Mitchell (2005), literature sources assist the researcher to gain a good understanding of and insight into previous research conducted on the same topic. Considering this, the literature review in this research was divided into three categories – primary, secondary and tertiary sources.

In line with the guidelines by Welman et al. (2005), primary sources on border security and space technology were the first occurrence of pieces of work consisting of both published and published sources. On the other hand, secondary sources consisted of books and journals in the field of border security, space technology, and PPPs. Other sources consulted were dissertations and theses from various local and international academic institutions.

The researcher followed the steps proposed by Creswell (2009) to review the literature. The first step was to determine the topic and find literature like the topic at hand. This was achieved by identifying the key concepts of this study, namely border security, space technology, and PPP, to link them to the objectives of the research and the research questions. Further to this, the researcher used the key concepts and the research questions to search for available literature from online libraries.

The researcher accessed peer reviewed journals, e-books, theses and dissertations, media reports, and published government reports. The researcher also visited various libraries in order to find material relevant to the research topic. After collecting the relevant material, the researcher browsed through the material in order to find literature that was relevant and would contribute to the research at hand. Throughout this process, the researcher kept references of all consulted material. Since most of the sources were in an electronic format, the researcher was able to store such in separate electronic folders and saved each file under the author's name.

5.9.2 Documentary sources

In addition to the literature review, the researcher used documentary sources, as indicated in Table 5.3, to collect data on the SANDF and its border security functions, and the related challenges. Document analysis is described by McMillan and Schumacher (2001) as another valuable qualitative data collection method.

De Vos et al. (2005) state that the different forms of documentation for research purposes could be diaries, official documents, media reports, and archival materials. In this study, the researcher used the research question and the aim of the study to find information relevant to the study.

Table 5. 3: Categories of documentary sources

Category	Speciality	Number of documents sourced
Sample E	SANDF Documents	36

In accordance with **Table 5.3**, the researcher studied and analysed official government documents consisting of official statements and media reports. Some documents, which were analysed in this research, were video and audio interview recordings by senior members of the SANDF, particularly on the issues and challenges of border security and migration management in South Africa. These documents were obtained mainly from the Internet and videos were sourced from YouTube, specifically relevant to the SANDF's border security operations. This method of data collection also served as a means of triangulation, which is described by Leedy and Ormrod (2001) as a multiple source of data collected in the hope that they congregate to support a particular theory.

De Vos et al. (2005) cite several advantages of document analysis. The authors (2005) suggest that document analysis saves the time and money required by the researcher to visit different research sites and further prevents the study from being influenced by the researcher's preconceived ideas on the research topic. In this instance, document analysis allowed the researcher to analyse the issues and challenges experienced by the SANDF on border security. It also allowed the researcher to grasp the issues and challenges of border security in South Africa from the official and expressed views of members of the SANDF (De Vos et al., 2005; Hodder, 2000). Considering this, the researcher is of a view that the collected documentary data served the same purpose as face-to-face interviews as it provided the researcher with insight on the issues and challenges of border security and management in South Africa from the expressed views of senior SANDF officials.

However, there are also disadvantages associated the use of document analysis. One such disadvantage is that there might be too many documents to be studied and analysed and they might require a lengthy period to analyse. Moreover, in some instances, the available documents might not have all the information required by the researcher as they were compiled for a specific purpose not necessarily aligned to the study at hand (De Vos et al., 2005; Hodder, 2000). This aspect was relevant in the

current study as the researcher could not find adequate information that could address the main theme of using PPPs to enhance border security in South Africa. Furthermore, the quality of the data collection procedures of such documents might be questionable, including the style of writing in which such documents were prepared. In addition, some contents of the available documents might not be clear to the researcher, or in certain instances, the available data might be arranged in such a way that makes it difficult for the researcher to conduct a proper analysis (Hodder, 2000; De Vos et al., 2005).

5.9.3 Semi-structured interviews

The researcher collected data by applying KIIs, which is defined by Kumar (1989), Given (2008), and Graton and Jones (2004) as a process of interviewing a small number of participants who have expertise and rich information on a topic. This process provided the researcher with the opportunity to solicit information from participants with insight on the nature of the problem of land border security in South Africa; the application of space technology to enhance border security in South Africa; and the role the private space technology sector plays in enhancing border security in South Africa.

The interview process also allowed the researcher to obtain recommendations from the participants om how to solve the problem at hand. Therefore, semi-structured interviews assisted the researcher to explore the meaning that the participants assigned to the phenomenon under research from both a practical point of view and based on expert or specialist knowledge (Charmaz, 1990; Creswell, 2009).

Considering the large number of participants who were anticipated to take part in this research, it would not have been feasible to conduct semi-structured interviews with all the potential research participants. As such, the researcher conducted semi-structured interviews with four categories of participants consisting of senior police officials responsible for land border security at selected land border posts in South Africa; researchers and experts on border security; researchers and experts on satellite technology; and researchers and experts on UAV technology, as depicted in **Table 5.3**.

The researcher chose these participants, as he believed that they possessed the necessary expertise and knowledge on land border security matters, as well as space technology. In order to achieve this, the researcher compiled and made use of an interview schedule which, according to Goddard and Melville (1996) and Marshall and Rossman (2006), should contain open-ended interview questions so that they allowed the researcher an opportunity to follow up on the answers provided by the participants.

It is also worth mentioning that each category of participants had a separate interview schedule. For example, it was not expected of an earth observation specialist to understand the challenges of border security in South Africa. However, it was expected of an earth observation specialist to shed light on how earth observation satellites could be effectively used to monitor remote border areas.

The questions posed to each category of participants were based mainly on the knowledge they had in their field of specialisation. Thus, the interview schedule for each of the four different categories of participants or samples contained the same questions respectively for each of the interview schedules. In this instance, the same questions were posed to the participants in the respective samples, as depicted in **Table 5.4**.

Table 5.4: Categories of research participants interviewed

Category	Speciality	Number of Participants Interviewed
Sample A	Border Security Specialists	4
Sample B	UAV Specialists	4
Sample C	Earth Observation Specialists	1
Sample D	Border Security Officials	5

McDonald and Headlam (2008) assert that semi-structured interviews are commonly used in qualitative approach and allow the researcher to address key themes rather than specific research questions. To achieve this, the researcher made use of an interview schedule which contained open-ended questions on these main predefined themes of border security, space technology, and PPPs.

The interview schedule contained questions which sought to find answers to aspects such as the challenges of land border security in South Africa; the type of space technology that might be applied to address land border security challenges in South Africa; and the extent to which the private space technology sector might be of value in enhancing land border security through the application of space technology in South Africa.

5.9.3.1 Telephonic interviews

Due to practical financial and resource constraints, the inability of the researcher to travel to all border posts, the inability to travel to all subjects' specialists in South Africa, and mainly, the restrictions imposed by the COVID-19 pandemic and the need to ensure the safety of the participants, the researcher opted to conduct virtual interviews with the identified participants. The virtual interviews consisted of telephonic voice and video interview sessions.

The video interview session provided the same advantages provided by one-on-one interviews as the researcher was able to observe the body language of the participants and observe other non-verbal communication by the participants. On the other hand, voice interview sessions could not provide the researcher with the opportunity to observe non-verbal communication. In both instances, there were moments when the researcher experienced telecommunication network connectivity challenges which hampered seamless communication between the researcher and the participants.

The researcher used a commercial transcription service to transcribe the audio recordings of the semi-structured interviews. After the transcripts were received, the researcher ensured that the transcribed audio recordings were transcribed correctly and that they did not contain obvious mistakes. All the audio recordings submitted to the external transcriber did not contain the names or the identities of the research participants. During the transcription of the audio recording, the transcriber used the names "interviewer" and "interviewee" to indicate each comment made by the researcher and the participants.

5.9.3.2 Email interviews

Apart from telephonic video and voice semi-structured interviews, the researcher also used email interviews for data collection. This is because it was difficult to schedule interviews with some of the identified participants. According to Fritz and Vandermause (2017), email interviews increase access to participants and encourage greater participation of working adults. These authors (2017) further mention that researchers can conduct email interviews with participants from all over the world without incurring additional expenses for travel and other related costs. Similarly, Gibson (2014) submits that with email interviews, participants can respond to questions at their own convenient time and at a pace suitable to them. Email interviews also allow participants to have more control of their participation in the study; thus, enhancing the level of ethical considerations more than it would have been with traditional face-to-face interviews (Mason & Ide, 2014).

Moreover, email interviews also allow the researcher to save money in transcription costs as the written responses by the participants can easily be converted into transcribed data; thus, resulting in significant cost savings compared to the costs associated with transcribing oral interviews (Gibson, 2010). However, email interviews are not without disadvantages. A disadvantage of email interviews is that it is often time consuming to craft the email response given by the participant, as opposed to oral interviews. Another disadvantage is that in email interviews, participants may be tempted to provide short and concise answers, and in some instances, they may decide to withdraw or not to answer certain questions (Gibson, 2014; Fritz & Vandermause, 2017). Although email interviews save the researcher transcription time and costs, it is more time consuming for a participant to write their responses than to give oral answers (Hawkins, 2018).

5.10 Qualitative data analysis

Qualitative data analysis is referred to as the non-numerical examination and interpretation of qualitative data and observations for the purpose of discovering underlying meanings and patterns of relationships (Babbie, 2007). In this research, the researcher analysed data obtained from the semi-structured interviews and

documentary sources by using thematic analysis. Thematic analysis is a method used to identify, analyse, and report patterns within data (Braun & Clarke, 2006).

The process was initiated by organising and categorising data that was collected from the semi-structured interviews and documentary sources (Mouton, 2001). Thereafter the researcher systematically analysed the data in order to identify sub-themes which has emerged against the pre-determined themes. The researcher did not embark on the process of analysing data that was collected through the literature review but used that data to support arguments for and against a particular point uncovered through documentary data, as well as through semi-structured interviews.

In order to simplify the process of data analysis, the audio recordings obtained during the semi-structured interviews were transcribed verbatim into notes so that they could be read, edited for accuracy, commented on, and analysed in order to identify common themes (Welman et al., 2005). The researcher further searched for phrases and themes and compared them with predefined categories that emerged from the literature on border security, space technology, and public-private partnerships. The purpose of this activity was to identify common themes and to establish words mentioned repeatedly by the participants.

Since the collected documentary data was not prepared by the authors or speakers in direct response to the research questions and aims of this research, the researcher had to examine large amounts of documentary data and select only data that was relevant to this research. Each identified documentary data was given a name – Document 1 up to Document 36. Thereafter, the researcher extracted paragraphs or lines in the identified documents that were relevant to the research questions and the aims of the study. Then, those paragraphs and lines were pasted into a Word document against the predetermined themes. For example, a paragraph or a line in a documentary source, which covered aspects of the challenges of controlling and monitoring the border in South Africa, was pasted against a relevant subheading in a destination document used for data presentation. Once that process was complete, the researcher analysed the said extract in a similar manner to the answers provided during the semi-structured interviews.

Qualitative data analysis can be a daunting task. However, this process was simplified by making use of Computer-Aided Qualitative Data Analysis Software (CAQDAS) (DeNardo & Levers, 2002; Corti & Gregory, 2011; Sanchez-Gomez, Martin-Cilleros & Sanchez, 2019). In this regard, the researcher made use of CAQDAS called "Atlas ti™" to code the semi-structured interview transcripts. This method simplified the analysis of textual data collected by the researcher and further made it easy to identify key themes as they emerged from the collected data. The researcher used the cutting and sorting method as a thematic method of data analysis. Welman et al. (2005) describe this method as a formal method of identifying themes. It involves the identification of the most important remarks in the transcriptions. Thereafter, the researcher pasted the identified remarks into a Word document with the participant number. Different piles of similar quotes from various participants were grouped together against a predetermined theme it represented.

5.11 Pilot interview

A pilot interview was conducted with a neutral participant who possessed general knowledge on border security matters. The pilot interview was undertaken prior to the actual research. A pilot interview sought to test a few variables related to the research and to correct initial problems before the researcher could embark on a full-scale collection of data (Gorman & Clayton, 2005). The pilot interview also provided the researcher with an opportunity to improve his interviewing skills and provided awareness on how well the researcher was prepared to conduct the actual interviews (Van Teijlingen & Hudley, 2001; De Vos & Strydom, 2011).

5.12 Trustworthiness

The term "trustworthiness" is more appropriate in qualitative research than the traditional quantitative criteria of validity and reliability (Edwards & Skinner, 2009). Trustworthiness occurs when the researcher is upfront about the research process and the analytic and ethical dilemmas that were encountered during the research (Saldana, 2011). In this research, the researcher ensured trustworthiness by complying with the requirements for credibility, dependability, transferability, and confirmability. This

was achieved by ensuring that the following aspects of trustworthiness were adhered to.

5.12.1 Credibility

Credibility refers to the methodological procedures and sources used to establish a high level of harmony between the research participants' expressions and the researcher's interpretations of them. This process seeks to ensure that there is a link between what the participants expressed and the themes and codes that emerge from the research (Given, 2008). The semi-structured interviews were recorded using an audio recorder. Moreover, the researcher cross-checked the answers provided by the participants by asking them to confirm the answers provided. Thereafter, the researcher transcribed the audio recordings verbatim.

On completion of the transcription process, the researcher conducted member checking to seek confirmation, congruence, validation, and approval of the interview transcripts (Kumar, 2011). Turner and Coen (2008) define member checking as a process of returning research products to research participants to obtain internal authentication. As recommended by Sandelowski (2008) and Harper and Cole (2012), this process formed part of the primary data collection process whereby the participants were asked to elaborate on and clarify their opinions during the semi-structured interviews. The researcher further supplemented this process by summing up the important views of a statement and by probing further with the participants to determine if he had grasped the content of their responses correctly. The researcher also compared the answers given by different participants for similarities and differences. The quality of the research was also strengthened by collecting literature from reputable sources such as academic textbooks, and peer reviewed journals.

5.12.2 Dependability

In order to meet the requirements for dependability, the researcher is required to provide ample, relevant methodological information to allow others to replicate the research. This process is equivalent to reliability in quantitative research (Given, 2008). The researcher ensured dependability by recording the participants' responses as they

were presented, making notes on non-verbal communication, cross-checking the answers provided by the participants by asking the same question differently, and recording any changes that arose during the research that might affect the quality of the data collected.

5.12.3 Transferability

Transferability is the extent to which the results of the research can be transferred to other contexts and situations beyond the scope of the research context (Given, 2008). In this research, the researcher ensured that the participants were relevant members of the population related to the research through purposeful sampling, whereby the participants were selected based on the extent to which they represented the research design, the limitations, and the delimitations of the research. Given (2008) and Kumar (2011) state that participants most consistent with the research design are likely to enhance the potential that readers can assess the degree of transferability to their given context.

5.12.4 Confirmability

Confirmability is equated with reliability and objectivity in quantitative research. This process seeks to provide evidence that the researcher's interpretations of participants' views are solely based on the participants' views and that the analysis of data and the resulting findings and conclusions can be verified as being that of the participants' perceptions. This requires the researcher to be objective and not influence the results of the research in any way (Given, 2008).

In order to ensure confirmability of the research, the researcher paid attention to how the phenomenon under investigation was described by listening to the participants' views on the topic at hand and he did not lead the participants to the answers that he hoped to obtain. Information contained in the literature was interpreted as it was, even if it was contrary to the researcher's preconceptions and ideas. In addition, the researcher ensured that only literature relevant to border security, space technology, and PPPs was collected. The researcher further identified statements in the literature that were relevant to the topic and excluded irrelevant statements; and sought divergent

views on some of the points under discussion and further analysed them in order to reach a valid conclusion.

5.13 Ethical considerations

Since research can have a very powerful influence on people's lives, the researcher gave thorough thought to the impact the proposed research might have on the topic under study and on society in general. The researcher complied with the principles of ethical research and further behaved in a manner that did not cause harm to the subjects of the research and society in general (McNeill & Chapman, 2005; Ellis, Hartley & Walsh, 2010). In this regard, the participants were given information about the research as contained in **Annexure D** and were further provided with informed consent forms and they signed the relevant informed consent forms as per **Annexure E** before participating in the research.

In addition to informed consent, the researcher ensured that the participants were protected against any physical or physiological harm during the research. This was achieved by encouraging participants to inform the researcher on any aspect that could affect their safety and psychological well-being before and during their participation in the research. The researcher also ensured that the participants took part in the research voluntarily.

Before commencing with data collection, the researcher applied for ethical clearance from the Durban University of Technology (DUT), which was issued as per **Annexure B** of this research. Thereafter, the researcher requested permission from the relevant border security entities. SAPS granted approval to conduct the research, as per **Annexure C**, whereas the SANDF as stated earlier, declined the researcher's request. The researcher also ensured that there was no misrepresentation of facts in the research. Findings were presented as they were, even if they were contrary to the researcher's beliefs or opinions. Moreover, all the sources consulted in this research were quoted and presented in the list of references. The thesis was also subjected to a plagiarism detection software, Turnitin and the receipt thereof is attached as **Annexure G**.

5.14 Anonymity and confidentiality

Anonymity refers to the steps taken by the researcher to protect the identity of the research participants (Rees, Garcia & Oakley, 2007), while confidentiality refers to attempts undertaken by the researcher to remove personal attributes of the respondents from the research records (Henn, Weinstein & Foard, 2006). Against this background, the responses of the participants were handled with strict confidentiality and were not shown to anyone else, except when they were required by the researcher's supervisor. The names of the participants were not recorded during the interviews and the participants were only be identified by numbers.

5.15 Chapter summary

In this chapter the researcher unpacked the problem statement, the scope of the research, and the research aim. This chapter also provided an overview of the key theoretical concepts used in this research, the value of the research, and the challenges encountered during the research. Moreover, the researcher examined the trustworthiness of the research and the ethical considerations. In the next chapter, the researcher will explore discuss the research findings.

CHAPTER 6

PRESENTATION OF THE RESEARCH FINDINGS

6.1 Introduction

This chapter presents the findings of the research. For this research, the researcher applied two data collection methods inclusive of documentary analysis and semi-structured interviews. As a key data collection method for this research, the researcher made use of an interview schedule to conduct semi-structured interviews with senior members of SAPS in various border areas in South Africa.

The researcher focused on what is termed the most problematic border areas, namely the Beitbridge border area between South Africa and Zimbabwe; the Lebombo, Kosi Bay and Golela border areas between South Africa and Mozambique; the Ficksburg, Maseru Bridge, and Van Rooyens Gate border areas, between South Africa and Lesotho; and the Oshoek border area between South Africa and eSwatini.

In general, the aims of the semi-structured interviews were to determine how senior members of SAPS viewed the problem of border security in their respective areas of operation, which space-based technological solution could be implemented to address the identified challenges, and whether there was a need to implement PPPs to achieve that.

The main questions to be answered by the participants were:

1) the most prevalent threats and risks to border security in their respective areas of operation;

2) the issues and challenges of border security in their respective border areas in South Africa;

3) the feasibility of employing space technology to enhance border security in their respective areas of responsibility; and

4) the role the private space technology sector could play in enhancing border security in South Africa in collaboration with state border security authorities and other private partners.

Apart from the above category of participants, the researcher conducted semi-structured interviews with experts and specialists in border security and other experts and specialists in space technologies, such as UAV and satellite technology. The aim of conducting semi-structured interviews with this category of participants was to seek expert or specialist contributions on the most prevalent threats and risks to border security in South Africa; the issues and challenges of border security in South Africa; the feasibility of employing space technology to enhance border security in South Africa; and the role which the private space technology sector could play in enhancing border security in South Africa in collaboration with state border security authorities and other private partners.

The semi-structured interviews with all the participants, who availed themselves for the interviews, were audio recorded with their permission. After the semi-structured interviews, the researcher listened to the audio recordings in order to familiarise himself with the content of the interviews. Verbatim transcription of the audio recordings commenced after the researcher had listened to them. Once the audio recordings were transcribed, the researcher began with the data analysis process.

It is also worth mentioning that not all the identified participants were available for personal semi-structured interviews due to their busy schedules or their inability to schedule appointments. As such, some participants opted for email interviews, where they provided written responses to the research questions and emailed the responses to the researcher. In this instance, there was no need to transcribe their responses.

As another method of data collection, documentary analysis was chosen because it gave the researcher the opportunity to analyse data presented by members of the SANDF on the threats and risks of border security in South Africa; the issues and

challenges of controlling and monitoring South Africa's land borders; the extent to which space technology can be applied to enhance border security in South Africa; and the possibility of implementing PPPs for enhancing border security through the application of space technology. This was after the SANDF declined the researcher's request to access and interview border security practitioners employed by the SANDF; thus, making it impossible for the researcher to obtain the required information through semi-structured interviews.

Given the above, documentary analysis enabled the researcher to understand the threats and risks to border security in South Africa; the issues and challenges of border security in South Africa; the extent to which space technology could be applied to enhance border security in South Africa; and the possibility of implementing PPPs for enhancing border security through the application of space technology from the expressed views of SANDF members. The documents analysed by the researcher consisted mainly of media statements and official statements by senior members of the SANDF.

These documents were both in written and in video formats and were easily accessible and useful in assisting the researcher to gain a better understanding of the SANDF's border security mandate. For example, media statements by the Minister responsible for defence in South Africa and senior SANDF officials were available on the official webpages of the SANDF; defence and security websites such as the Defenceweb and ISS; and on various news websites, such as the South African Broadcasting Authority (SABC). Thus, the data collection processes for this research consisted of two data sets. Data set one was for documentary sources only, while data set two was for semi-structured interviews only.

During the data analysis process, the data collected through personal and email semi-structured interviews, and documentary analysis was interpreted through the identification, listing and analysis of codes. The codes were created using Atlas ti™ and were assigned to passages of text in the transcribed interviews. In addition, the data were grouped into groups of codes in line with the interview questions. For example, those codes that fell within the category of the threats and risks of border security were

grouped together; and those who fell in the category of issues and challenges of border security in South Africa were grouped together.

The codes that fell within the category of the feasibility of employing space technology to enhance border security were also grouped together under their own themes. Lastly, those codes that covered the aspect of the role of the private space technology sector in the enhancement of border security in collaboration with the public border security sector were also grouped together.

6.2 Findings of the documentary analysis process

The findings set out in this section of the research are all based on the information obtained through documentary analysis. Documents analysed by the researcher in this research were official statements; media statements; and responses to parliamentary questions by senior officials of the SANDF and the Ministers of Defence and Military Veterans in South Africa. These documents were all in electronic format and included video and audio recordings. Thus, it can be concluded that the statements by senior SANDF officials as contained in electronic documents, and audio and video recordings, represented the expressed views of such officials on the phenomenon under research.

Although the documents collected by the researcher were not prepared for the purpose of this research, the researcher is of a view that the said documents could be analysed in the same way as the transcripts of the semi-structured interviews conducted between the researcher and the research participants. This is because they were created to inform the public of the various threats and risks to border security in South Africa; the current issues and challenges of border security in South Africa; and the plans to improve the level of security at South African borders. They also contain direct statements by senior officials of the SANDF on issues related to this research.

The researcher used the aim of the research and the research questions to determine the type of information to be sought from the documentary sources. Thus, the documents were analysed against the following research questions:

1) Research question 1: What are the current threats and risks to border security in South Africa?

2) Research question 2: What are the current challenges related to the monitoring and controlling of land borders in South Africa?

3) Research question 3: To what extent can space technology be applied to enhance land border security in South Africa?

4) Research question 4: To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

The analysed data is presented in a specific sequence. It begins with documentary analysis, where several documentary sources are analysed by the researcher. In this process, the researcher introduces the main research question and the purpose of the enquiry. Thereafter, the researcher uses tables to present the frequencies of subthemes, which emerged from the analysed documents, and the relative frequencies of those subthemes, which are a proportion of each category of the predetermined themes. This process is followed by graphical presentations using the pie charts of the results of the subthemes, which emerged from the analysed documents.

Each category of subthemes is represented by a slice of the pie. Thus, the area of the slice in a pie chart represents the proportional percentage of subthemes against a particular theme. Graphical displays are simply relative frequencies presented in the earlier table multiplied by a 100 to give a percentage. Thereafter, the tables and graphic presentations of subthemes are followed by verbatim quotations of at least two direct quotations from documentary sources in order to provide a more inclusive insight into the data being analysed.

6.2.1 Threats and risks to border security in South Africa

The analysis of the documents revealed several threats and risks to border security in South Africa. These threats and risks consisted of illegal migration, human trafficking

and smuggling, livestock theft, drug smuggling, wildlife trafficking, the smuggling of stolen vehicles, and the poaching and trafficking of wildlife. These threats and risks vary from one border area to another; for example, livestock theft is more prevalent in the South Africa-Lesotho borders, whereas illegal human migration and drug smuggling are said to be more prevalent in the South Africa-Zimbabwe and South Africa-Mozambique borders.

The total number of sub-themes, which emerged from the documentary analysis process against the main theme of the threats and risks to border security, was four. Moreover, the total frequency of the sub-themes, which emerged from the responses provided by the participants, was 14. **Table 6.1** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

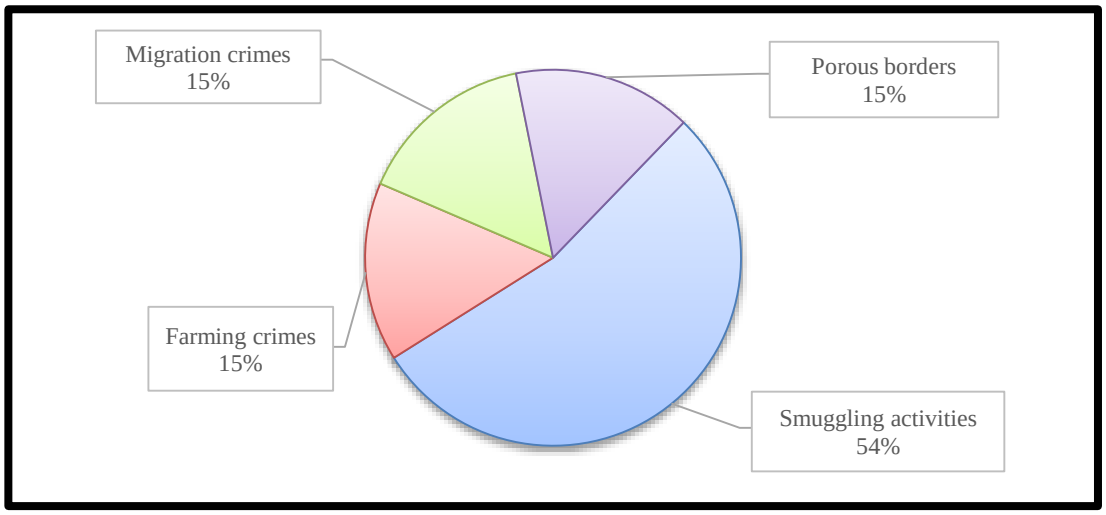
Table 6.1: Opinions of SANDF officials on the threats and risks to border security in South Africa.

Threats and risks	**Frequency**	**Relative Frequency**
Smuggling activities	7	0.54
Migration crimes	2	0.15
Porous borders	2	0.15
Farming crimes	2	0.15
Total	**14**	**1.00**

The analysis of documentary sources, as presented in **Figure 6.1,** suggests that smuggling activities in the border environment, which consist of the smuggling of dagga, illicit cigarettes, goods, natural resources, and small arms, accounted for 54% of the cross-border threats and risks in South Africa.

On the other hand, farming-related crimes such as illegal grazing and stock theft accounted for 15% of the total threats and risks. Similarly, human migration related criminal activities such as border jumping and human smuggling, and the porousness of the border were mentioned as some of the prevalent cross-border criminal activities with a relative frequency of 15% each.

Figure 6.1: Opinions of SANDF officials on the threats and risks to border security in South Africa.



Given the challenges of the smuggling of vehicles across South Africa's borders, particularly the South Africa-Mozambique borders, Colonel Merlin Albertyn of the SANDF indicated that they had put in place physical measures along the borderline to curb the increase in smuggling of vehicle across the border (DefenceWeb, 2020). Similar sentiments were echoed by the Minister of Defence, Nosiviwe Mapisa-Ncqakula, who during her visit to the border area of Mbuzini between South Africa and Mozambique also said that vehicles and livestock were being smuggled across South Africa's borders into Mozambique.

The Minister of Defence made the following statement in relation to some of the threats and risks to border security in South Africa, particularly on the South Africa-Mozambique borders:

> "We know that your cars and livestock are being smuggled through these borders to either Swaziland or Mozambique. We want you to be eyes and ears of the state. Let's fight these crimes together" (DefenceWeb, 2020).

A further elaboration on the threats and risks of border security in South Africa was provided by Colonel Gopane, who outlined several threats and risks to border security in South Africa, especially on the South Africa-eSwatini border. The threats and risks

mentioned by Colonel Gopane were illegal border crossings, wildlife poaching, livestock theft, and the smuggling of dagga:

> "Different areas of the border are susceptible to different types of activity. On the Swaziland border, for example, issues include the illegal crossing of schoolchildren, the smuggling of dagga, cattle rustling, goods smuggling, illegal mining and the unrestricted movement of people" (DefenceWeb, 2020).

The porousness of the borders, poor migration control measures and other cross-border criminal activities such as the smuggling of stolen goods, natural resources, and small arms and weapons were also acknowledged by the DOD as critical border security threats and risks in South Africa (ISS, 2010). Given the magnitude of the border security threats and risks facing South Africa, the Minister of Defence said the following during the Homeland Security Africa Conference held in Pretoria, South Africa on 17 October 2017:

> "The securing of our territorial integrity has become more of a challenge with the asymmetrical nature of warfare and conflicts afflicting the world's regions. We are thus not immune even to these, be it cyber security threats; the rise of extremism; threats and opportunities of migration; border and port security, to mention but some of the myriad of challenges facing us as we carve our national security strategy and implement the BMA, encompassing all of the role players within the security sector and beyond, state and non-state actors included" (DefenceWeb, 2009).

The above analysis of documentary sources indicated that similar views were held by the various members of the SANDF on the nature of the threats and risks of border security in South Africa. It also highlighted the most prevalent border security threats and risks in specific border areas, compared to other border areas.

6.2.2 Challenges of border security in South Africa

The challenges of controlling and monitoring South Africa's borders, which were identified during the documentary analysis process, consisted of several fundamental factors. These factors included nut are not limited to aspects such as the length of the South African borders; the harsh border terrain, which is often difficult to access and patrol by foot or using vehicles; inadequate resources to patrol the borderline; and the absence of a fence in many parts of the South African border, and where a fence is present, it is merely an agricultural fence which does not have any deterrence value to a variety of cross-border criminal activities.

The total number of subthemes, which emerged under the predefined main theme of the challenges of border security in South Africa, was five. Additionally, the total frequency of sub-themes, which emerged from the responses provided by the research participants, was 22. **Table 6.2 as** depicted in this chapter provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

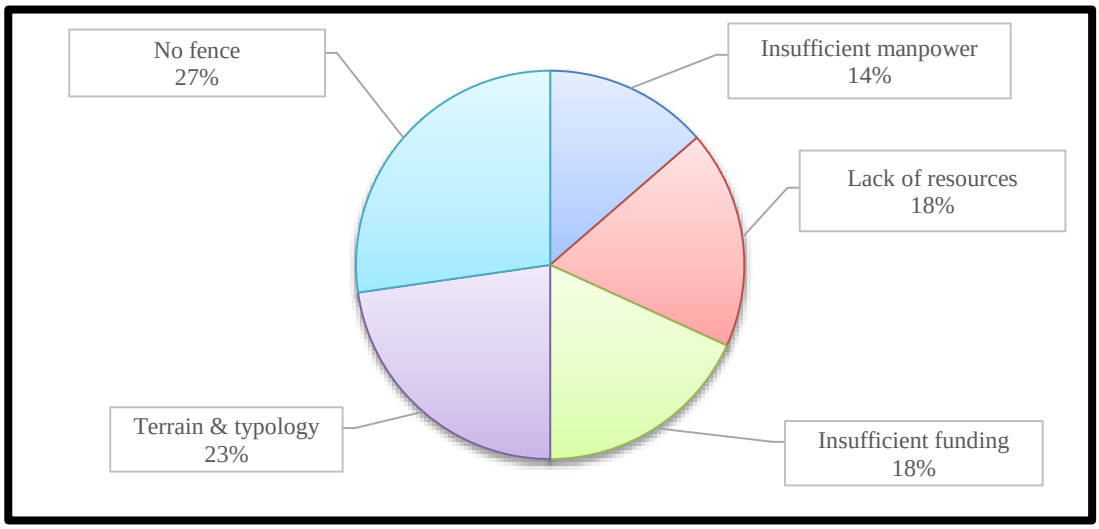
Table 6.2: Opinions of SANDF officials on the challenges of border security in South Africa

Challenges of border	**Frequency**	**Relative frequency**
Terrain	5	0.23
Funding	4	0.18
Resources	4	0.18
Manpower	3	0.14
Fence	6	0.27
Total	**22**	**1.00**

During the documentary analysis process, the researcher identified specific challenges as the main challenges of border security in South Africa, namely the absence of a borderline fence with a relative frequency rate of 27%, an unfavourable border terrain and typology (23%), and the lack of resources (23%) (see **Figure 6.2**).

These challenges were followed by the lack of resources and insufficient funding, each with a relative frequency of 18%. A further challenge experienced by the SANDF in the control and monitoring of South Africa's borders was recorded as insufficient manpower (14%).

Figure 6.2: Opinions of SANDF officials on the challenges of border security in South Africa



Given the above description of border security challenges in South Africa, Lieutenant General Barney Hlatshwayo, who is the Chief of the Joint Operations Division of the SANDF, highlighted some critical challenges facing the SANDF in controlling and monitoring South Africa's borders. The challenges mentioned by Lieutenant General Hlatshwayo include severe human resources deficits to patrol South Africa's borders (DefenceWeb, 2019).

In support, the Minister of Defence added that the SANDF's border safeguarding mission would have been a great success if the SANDF had adequate human resources dedicated to border safeguarding (Thobela, 2017). Considering this, Lieutenant General Hlatshwayo made these remarks in relation to the shortage of staff:

> "Where do we stand? We are at 15 companies. Why? It is a matter of the resources. The plans are still there, they have been approved and ultimately if we are well resourced, we will roll out those 22

> companies. Even 22 companies are not sufficient to protect this vast area" (DefenceWeb, 2019).

Lieutenant-General Vusi Masondo also raised concerns about the financial constraints experienced by the SANDF. He said that the South African Army did not have the necessary financial muscle and human resources to provide the required levels of border security in South Africa (Ndlazi, 2018; *Pretoria News*, 2018).

Similar sentiments were echoed by the Minister of Defence who indicated that this dire situation of inadequate funding affected the SANDF's ability to execute its border-safeguarding mandate (Heleta, 2017). The Minister reiterated that there was the need to take urgent action to capacitate and equip the SANDF, expand its human resource component, and fund its operational deployments. The Minister said the following:

> "These and other shortcomings must be addressed to prevent the steady decline of the SANDF and the potentially disastrous consequences that could follow…The question crucially posed by the Defence Review is, what is it that we want the SANDF to do at home, in the region and the rest of the continent? Once that question is definitively answered, adequate resources must be allocated to enable it to execute its mandate with the requisite effectiveness and efficiency" (South Africa, 2014).

Considering the challenge of inadequate resources to safeguard South Africa's borders, the Secretary of Defence, Dr Sam Gulube, said:

> "The DOD is considering new methods of fulfilling its border safeguarding function in the context of a declining departmental budget and commensurate resource allocation. The draft Border Safeguarding Strategy has been developed to secure the air, land and maritime borders during FY2017/18" (DefenceWeb, 2018a).

The shortage of resources, as indicated above, seems to affect the morale and the wellbeing of the members of the SANDF who are tasked with border security at the

various borders in South Africa. Lt Colonel Elaine van Staden had the following to say:

> "It's very demoralising if you feel like you're fighting a losing battle. With more support and resources, soldiers feel motivated to continue the fight" (Nel, 2017).

Another factor that makes it difficult for the SANDF to effectively monitor and control South Africa's borders is said to be the harsh terrain and the length of the borders. South Africa's border terrain creates a challenge for border security authorities to control and monitor the border areas, especially in the absence of suitable equipment for patrolling rough terrain.

Similarly, Lt Colonel Van Staden commented on the poor road conditions on the South African borders. She indicated that it was often difficult to pursue criminals at South African borders due to the poor road conditions (Nel, 2017). Considering this challenge, a presentation by Lieutenant General Matanzima of the SANDF to the Portfolio on Defence pointed out that:

> "The Defence Force required special vehicles for use in the mountainous areas, such as the Lesotho passes. Such special capability vehicles would include ambulances. The running costs of such a vehicle were a huge cost driver".

In support of the above, Captain Sifiso Nene indicated that it was often difficult to apprehend cross-border criminals once they had been spotted due to the unfavourable border terrain:

> "We catch some and we lose some because of the terrain and bushes and for the fact that these people know the area well. They grew up here herding cattle and playing on these plains" (Mhlongo, 2018).

Further sentiments were echoed by Lieutenant Colonel Gopane who mentioned that the extreme terrain in which members of the SANDF operate makes it difficult for them to conduct vehicle patrols and causes significant damage to patrol vehicles:

> "The areas in which soldiers are deployed often has extremely difficult terrain that is only passable with 4×4 vehicles, but even these take a beating; tyres typically last three months and it is normal for vehicles to have multiple flat tyres in a single day" (Martin, 2018).

Documentary sources also highlight that the length and breadth of the South African borders, which is 4471 kilometres, makes it difficult for the SANDF to patrol it. This is according to Lieutenant General Hlatshwayo of the SANDF (Martin, 2019). In another view, the President of South Africa, President Cyril Ramaphosa, also mentioned that the length and breadth of South Africa's borders requires extensive resources for it to be monitored effectively. The President further indicated that, despite dedicating adequate resources for border security, the length of the borders made the task difficult:

> "… has developed a long-term strategic view to focus on specific threats to the sovereignty of the Republic and the authority of the state. Government has deployed a significant amount of resources and put in place extensive measures to control our borders but the extent of the challenges and the sheer length of our land and sea borders show more needs to be done" (DefenceWeb, 2019).

The absence of, or the inadequacy, of a border fence also creates a problem for South Africa's border security authorities. The absence of a border fence on most parts of the South African borderline, and the costs associated with erecting a border fence on the entire South African borderline, were significant challenges faced by border security authorities. In addition, the costs associated with the maintenance of the existing border fence seemed to be a factor that the SANDF was not in favour of. This situation created problems for border guards as criminal elements cut through the border fence and moved between South Africa and its neighbouring countries with ease (Thobela, 2017; Martin, 2018). For example, Colonel Gopane said that:

> "A common complaint from soldiers on the border is the ease with which criminals cut the fence and cross over the border fences… used to be electrified but no longer are, making it much easier for them to be taken down. The Kruger National Park has good fences as these are largely paid for by SANParks but other areas of the border have fences in very poor condition" (Martin, 2018).

Rear-Admiral Schultz's reply to a question by the Portfolio Committee on Defence highlighted that all South Africa's borders had a fence of some kind. He further said that the South Africa-Lesotho and the South Africa-Namibian borders were separated by a normal cattle fence. This was mainly to keep livestock out. In contrast, the South Africa-Mozambique border was separated by a double military fence with barbed wire in the middle. However, part of this fence has since been removed (PMG, 2010).

Rear-Admiral Schultz further elaborated that the South Africa-Zimbabwe border in the Kruger National Park had a similar fence, which had been eaten away by animals. Considering all this, Rear-Admiral Schultz's strong comment was that it was costly to maintain a physical barrier and one of the ideas discussed by the SANDF was to install sensors, which would enable reaction teams to respond to warnings from the sensors (PMG, 2010).

The Minister of Defence made the following remarks on South Africa's border fence and infrastructure constraints:

> "This is a major programme, the infrastructure is not the best it can be, the fence is not in a good state, we have over 2000m long land border we have to look after and that requires both financial, technology and human resources, but we are up for the task and I am confident that many South Africans are happy that their troops are back on the border" (Siyabona Africa, 2020).

The analysis above highlighted a number of challenges relating to the provisioning of effective border security in South Africa. Budget constraints and the shortage of human

resources have been widely reported as major challenges faced by the SANDF in their border security mandate.

Other challenges revealed by the documentary analysis include the length of the South African border, the harsh border terrain, and poor road infrastructure, which make it extremely difficult to monitor South Africa's borders. The absence of a borderline fence on most parts of the country's borders has also been a serious matter of concern raised by senior members of the SANDF.

6.2.3 Application of space technology to enhance border security in South Africa

The previous section highlighted some critical challenges facing the SANDF in controlling and monitoring South Africa's borders. Factors such as the length of the South African border; harsh terrain, which is often difficult to patrol; inadequate resources; and the impossibility of erecting a fence along the entire border areas were highlighted as some of the major challenges of border security in South Africa.

In this section of the research, the researcher explores technological means to close the identified gaps in the provision of effective border security in South Africa. The function of border security comprises a combination of socio-technical aspects related to that function.

Technology is one of those socio-technical aspects and continues to play a significant role in the enhancement of border security in many advanced economies. This section of the research seeks to explore the feasibility of employing space technology to enhance border security in South Africa.

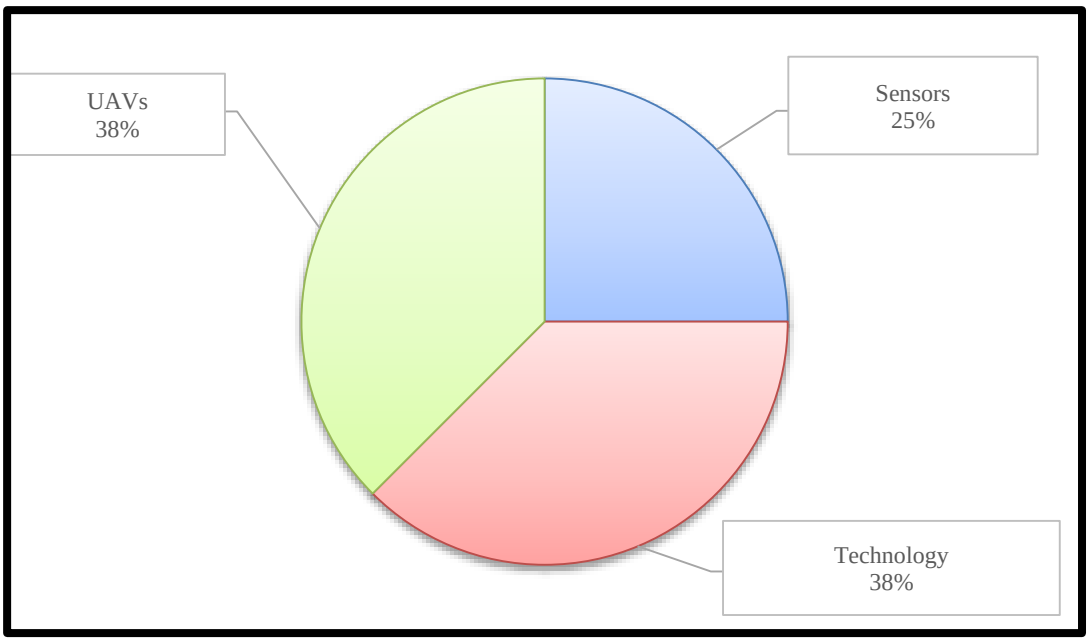
The total number of sub-themes, which emerged against the main theme of the application of space technology for border security, was three. In addition, the total frequency of sub-themes, which emerged from the responses provided by the participants, was eight. **Table 6.3** provides the frequency of each subtheme and their frequency relative to other subthemes mentioned by the participants.

Table 6.3: Opinions of SANDF officials on the use of technology for border security in South Africa

Type of technology	Frequency	Relative Frequency
UAVs	3	0.38
Sensors	2	0.25
High-tech equipment	3	0.38
Total	**8**	**1.00**

Considering the opinions of the participants on the use of technology for border security in South Africa and their opinions on the most suitable type of space technology for that particular purpose, the subthemes that emerged most during the documentary analysis process, as depicted in **Figure 6.3**, were the deployment of hi-tech technology (38%); the utilisation of UAVs (38%); and the installation of sensors along the borderline (25%).

Figure 6.3: Opinions of SANDF officials on the use of technology for border security in South Africa



Given the above and as referred to by the South African Minister of Defence, Nosiviwe Mapisa-Ncqakula during a media conference, government officials in South Africa are looking at deploying drones at some of the country's problematic borders to improve

national security and to prevent foreign nationals from entering illegally. Referring to an earlier comment by the Minister, the SANDF has only 15 army companies deployed on South Africa's borders. This, according to the Minister, is insufficient to protect South Africa's borders. Considering this, the Minister said:

> "We need technologies and sensors…We have challenges in maritime…We don't have enough men" (Katzenellenbogen, 2017).

The Minister further stated:

> "We have reached a point where we believe we should not be moaning about the number of companies [military units], the numbers of warm bodies, you have on the borderline. We should now look at innovative ways, look at technology. For instance, [South Africa] is a big producer of unmanned aerial vehicles and we are now looking into that…We think that through this, we will be able to win the war against illegal migration; we will be able to win the war against porous borders" (DefenceWeb, 2017).

The Chief of the SANDF, General Solly Shoke, also commented on the need to have a better combination of socio-technical aspects of border security, such as border guards, and security technologies, such as sensors, to enhance border security in South Africa:

> "More needs to be done to mitigate the porousness of our borders and this, given adequate resources, will require an increase of soldiers in the borderline and the use of force multipliers that will enable a real time picture of our borders. To this effect, the SANDF has drafted and completed Border Safeguarding and Sensor Strategies whose implementation plan, if appropriately funded, will considerably mitigate the porousness of the borderline" (DefenceWeb, 2019).

On the issue of technology for border security in South Africa, the Commander-in-Chief of the SANDF, President Cyril Ramaphosa, reiterated the need to integrate hi-

tech equipment with the human element of border security in order to address cross-border criminal activities:

> "I am certain we will be able to address issues of illegal migration, drug and human trafficking and other cross-border crimes. The deployment of personnel needs to be augmented with resources such as hi-tech equipment to cover such an extensive borderline – be it on land, sea or air" (DefenceWeb, 2019).

The need to acquire and utilise hi-tech assets for border security in South Africa has been noted by Sentech, a state-owned enterprise that showed an interest in acquiring sophisticated UAVs for use on South Africa's borders. Sentech's intention is to create a fleet of drones with the capability to take off by themselves, figure out the details of their own flight path, communicate with one another and sensor towers on the ground, and alert human operators to anomalies that could imply an attempted illegal crossing or other incursion (Business Insider, 2020).

The proposed type of drones should also be able to issue warnings automatically to possible border jumpers, such as "move away from the boundary, you are entering a restricted area". Moreover, at a central command centre, control room operators would be able to access live, high-definition videos of activities along the border. This data could also be augmented with data from other technologies, including fixed on towers between 15 and 45 metres high (Business Insider, 2020). According to Sentech:

> 'The system should assist with identifying threats faster and allow operating personnel to instantly spot potential threats with confidence,' says Sentech, with tracking of humans, cars, and 'other objects' (Business Insider, 2020).

South Africa has the capability to develop hi-tech equipment for defence and security. One such example is the development of the Indiza drones, which according to the Chief of the South African Army, Lieutenant General Lindile Yam, have been deployed to the Democratic Republic of Congo (DRC) to strengthen the South African Army's intelligence capabilities. These drones have been developed locally by the

CSIR and are easy to mobilise. They can be folded up into small containers for deployment and can fly for over an hour at distances of up to 10 km. Camera pods with day and night cameras can also be mounted on the frames of the drones (Martin, 2019).

Other hi-tech assets such as satellites could also be adopted for border security in South Africa. On this issue, Rear-Admiral Schultz stated that the SANDF did not use satellites to monitor the borders, but obtained satellite images for specific border areas, particularly for Geographical Information Systems (GIS) information. He further said that the SANDF did not own satellites – it does not even use them for any real-time observation. However, Rear-Admiral Schultz indicated that the SANDF rented satellite time from other sources for GIS purposes (PMG, 2010).

The analysis of documentary sources reveals that there is a need to introduce hi-tech assets such as UAVs and satellites to enhance border security in South Africa. Senior officials of the SANDF concur that space-based technologies such as UAVs and satellites can be integrated with other socio-technical aspects of border security such as sensors and border guards in order to enhance border security in South Africa.

6.2.4 Public-private partnerships for enhancing border security in South Africa through space technology

The previous section of this research explored the extent to which spaced-based technology could be utilised to enhance border security in South Africa. In this section, the researcher seeks to assess the possibility of forming effective partnerships between the private space technology industry and border security authorities for the provision of effective space technology, which could be applied in border security in South Africa.

As one of the socio-technical factors of border security, technology, plays a critical role in the provision of any form of security including border security. Several developed countries are investing adequately in hi-tech assets for border security. The private sector also plays a critical role in security technology innovation and development.

The analysis of documentary sources revealed that South Africa has a strong private hi-tech industry, which is capable of innovating and developing technologies for defence and security. The analysis of documentary sources also indicated that South Africa has the capacity to produce security technologies such as drones. Considering this, the Minister responsible for Defence, Minister Mapisa-Ncqakula asserted that South Africa has the capability to produce UAVs for border security. The Minister said the following:

> "[South Africa] is a big producer of unmanned aerial vehicles and we are now looking into that,' she said. 'We think that through this, we will be able to win the war against illegal migration; we will be able to win the war against porous borders" (Kesteloo, 2019).

The Minister further stated that the private sector could play a critical role in the development of the required technologies for border security in South Africa. She emphasised the need to co-opt the capabilities of the private sector and state-owned entities in order to provide technological solutions that would address the challenges of border security in South Africa:

> "On the optimization of defence technologies and beyond, I am happy that the industry and allied partners are also with us today and expect that they must expand more on how they see us ensuring indigenous innovations and expertise is utilised as we set up the BMA. This is on the basis that there is a lot of intellectual property, which resides within the RSA by both state-owned entities and the private sector. Therefore, as the process to roll out the BMA unfolds, care needs to be taken that the IP is retained and even further enhanced. This is on the basis that we have the tendency to look offshore for readymade solutions, when there exists these indigenous technologies and an opportunity to expand it even further. Admittedly, our defence industry at the same time needs to rise to the challenge and be able to deliver world-class products in time, especially for the South African market despite looking abroad… South African technologies include a variety if systems and

> equipment... inter alia sensors, seismic detectors, radars and radar systems, surveillance optronics, unmanned aerial vehicles (UAVs), indigenous patrol aircraft and maritime vessels. The list goes on and on and looking at the spread of available and developing technologies, these can and should be easily enhanced to meet at least 60% of our technology localisation to realise border security" (Department of Defence, 2017).

Other forms of partnerships between the private sector and border security authorities were noted by Lt Colonel Elaine van Staden of the SANDF who indicated that the SANDF worked together with Tracker, a vehicle tracking company in South Africa, and they have established an early warning system to detect stolen vehicles (Martin, 2019).

The further involvement of other parties in border security matters is as per the comments of Rear-Admiral Schultz who indicated that the SANDF rented satellite time from other sources for GIS purposes (PMG, 2010). Moreover, the CSIR has developed a drone for the SANDF for use in their missions, such as for intelligence gathering (Martin, 2019). Sentech has also shown an interest in acquiring sophisticated UAVs for use on South Africa's borders (Business Insider, 2020).

In this section of the research, the researcher analysed documentary sources regarding the SANDF on its border security mandate. The researcher analysed documents, which highlighted the threats and risks to border security in South Africa and the challenges of border security in the country.

The researcher also examined the views of members of the SANDF on the application of space technology to address border security challenges in South Africa; and the implementation PPPs to address border security challenges through the application of space technology. The next section will discuss the findings of the semi-structured interviews.

6.3 Findings of the semi-structured interviews

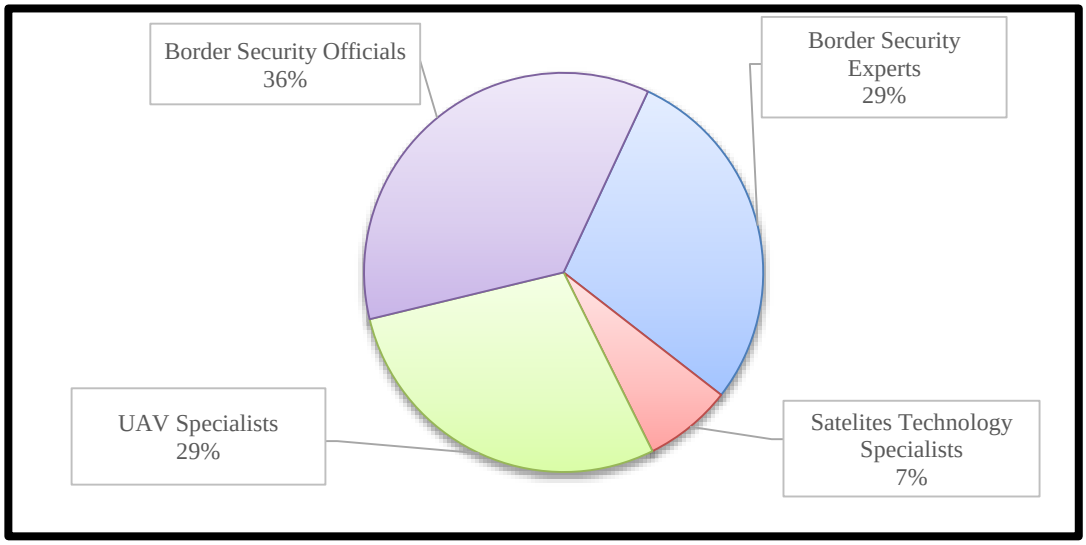
In this section, the researcher presents the findings of the semi-structured interviews with various categories of participants. Similar to the documentary analysis process, as discussed earlier, the researcher presents the results of the semi-structured interviews in line with the interview schedule. Firstly, the researcher introduces the main predefined theme and the purpose of the enquiry. Thereafter, the researcher uses tables to present the frequencies of subthemes, which emerged from the responses of the participants, and the relative frequencies of those subthemes, which are the proportion of the participants' responses to each category of themes.

The above process is followed by a graphical presentation using pie charts of the results of the responses presented by the participants; each category of subthemes is represented by a slice of the pie. Thus, the area of the slice in a pie chart represents its proportionality to the percentage of responses in that theme. Graphical displays are relative frequencies presented in the earlier table multiplied by a 100 to provide a percentage. Thereafter, the tabular and graphic presentations of subthemes or codes are followed by verbatim quotations of at least two direct quotations in order to provide more inclusive insights into the data being analysed.

Figure 6.4 indicates that most of the participants, who took part in this research, were border security officials. They accounted for 36% of the total number of the participants who participated in this research. They are followed by UAV experts and security experts at 29% each. The least number of participants, who took part in this study, were satellite or earth observation specialists. They accounted for only 7% of the total number of participants.

Only one participant in the population of satellite or earth observation specialists was able to take part in the study. This is despite the researcher's efforts to interview more participants. The researcher invited more than 20 participants in the field of satellite technology, requesting their participation in the research, but they did not respond to the request of the researcher. Only one potential participant declined the invitation. Despite this, the sole participant who took part in the research provided in-depth and rich data about the phenomenon under investigation.

Figure 6.4: Categories of research participants



Considering the different levels of knowledge and expertise of the four categories of participants, the researcher compiled four different interview schedules to address research questions that were relevant to each category of participants. Thus, border security officials were interviewed using an interview schedule designed by the researcher for border security officials. Border security experts were also interviewed using an interview schedule designed for border security experts.

Similarly, UAV specialists and satellite technology specialists were interviewed using interview schedules designed for these categories of participants respectively. Given this background, the first step to be taken by the researcher in this section of the study will be to separate the presentation of the findings of each category of participants. This will be followed by an integration of the findings as key observations. This process will allow the researcher to gain a clear understanding of the varying and independent experiences of each category of participants on the phenomenon being researched. Moreover, this process will allow the researcher to triangulate the data collected by looking at the similarities of the responses from each category of participants and by looking at the dissimilarities of the responses provided by each category of participants based on their unique set of expertise.

The findings of the research will be presented by indicating the subthemes, which emerged from the responses of the participants, and further the frequency with which

they were mentioned by the participants as well as the relative frequency of the subthemes.

The researcher will also use charts and assign percentages to illustrate the frequency of sub-themes. For in-text discussions, the frequency of subthemes will be presented by indicating the relevant percentage after the subtheme. Similar to the document analysis process, transcripts of the semi-structured interviews and emailed responses were analysed against the following research questions:

1) Research question 1: What are the current threats and risks to border security in South Africa?

2) Research question 2: What are the current challenges related to the monitoring and controlling of land borders in South Africa?

3) Research question 3: To what extent can space technology be applied to enhance land border security in South Africa?

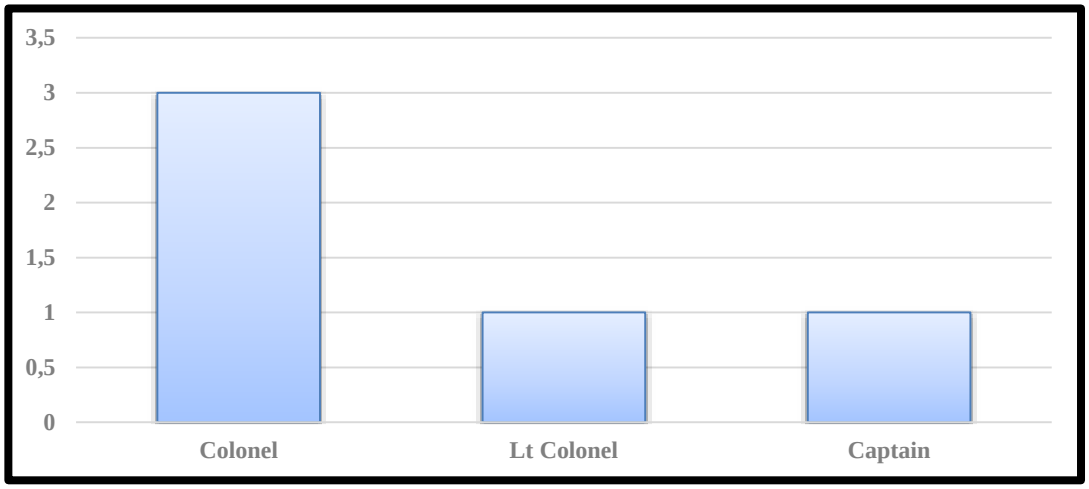
4) To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

The researcher will begin by presenting the findings of the interviews with the border security officials, followed by the findings of the interviews with the border security specialists. Thereafter, the researcher will present the finding of the interviews with the satellite technology expert, followed by the UAV specialists or experts.

6.3.1 Border policing officials

In this category of participants, five SAPS participants, as displayed in **Figure 6.5,** were interviewed by the researcher. These participants consisted of border security officials with the ranks of colonel, a lieutenant colonel, and a captain. The officials are responsible for land border security at various border areas in South Africa.

Figure 6.5: Ranks of border policing officials



6.3.1.1 Threats and risks to border security in South Africa

As an opening question, the researcher wanted to explore the participants' understanding of border security. The research asked the participants to define border security in their own words. All five participants defined border security as a set of measures devised by border security authorities to prevent and regulate illegal cross-border activities. Considering this, Participant 10 defined border security as follows:

> "Border security is the protection of our border from illegal movement of weapons, drugs, contraband while promoting a lawful entry to our country".

Participant 12 defined border security as follows:

> "According to my understanding, it is the effective and efficient protection of our borders from illegal movement of goods, people and drugs".

Lastly, Participant 9 defined border security in the following manner:

> "Ok, okay, so it's a measure that's put in place to regulate the movement of persons between the two countries".

After the above question, the researcher wanted the opinions of the participants on the most prevalent threats and risks to border security in their respective areas of operation. To this effect, the five participants provided their opinions and mentioned an array of threats and risks that were most prevalent in their area of operation. In total, the participants mentioned three categories of border security threats and risks applicable to their area of operation. The threats and risks mentioned by the participants consisted of migration-related crimes, cross-border smuggling activities, and farming-related crimes.

The total number of subthemes, which emerged in this line of enquiry, was three, with the total frequency of responses provided by the participants in relation to the most prevalent threats and risks at South African borders being 15. **Table 6.4** presents the frequency and the relative frequency of the subthemes or codes, which emerged during the interviews with the participants on the main theme of the threats and risks of border security in South Africa.

Table 6.4: Opinions of SAPS officials on the threats and risks to border security in South Africa.

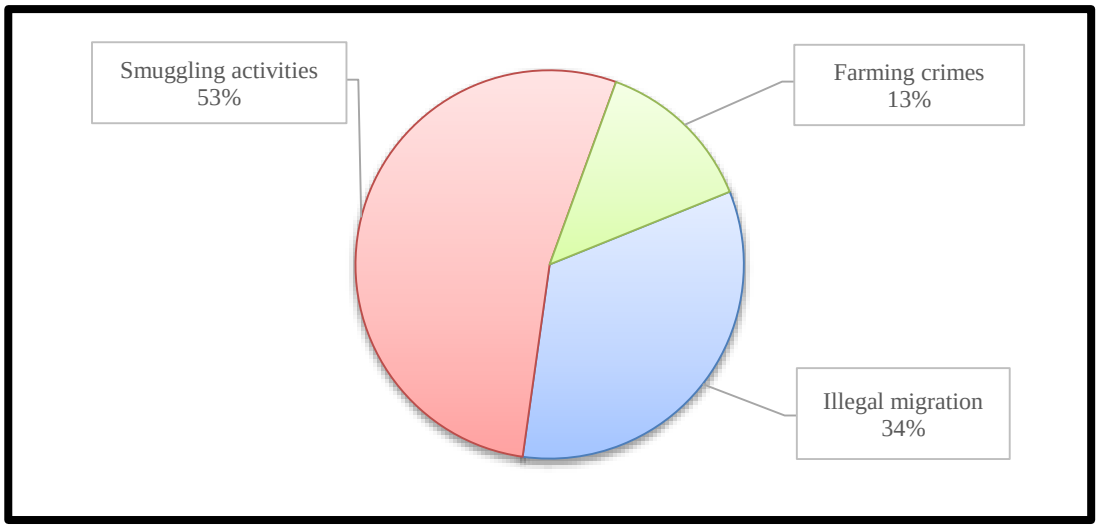
Threats and risks	**Frequency**	**Relative Frequency**
Migration crimes	5	0.34
Smuggling activities	8	0.53
Farming crimes	2	0.13
Total	**15**	**1.00**

Figure 6.6 shows that the participants mentioned cross-border smuggling activities as the most prevalent threat and risk, with a relative frequency rate of 53%. Cross-border smuggling activities consisted of the smuggling of stolen vehicles, drugs, dagga, goods, and illicit cigarettes.

Other prevalent cross-border threats and risks mentioned by the participants were human migration-related crimes, such as border jumping, human smuggling, and human trafficking, with a relative frequency rate of 34%. The participants also

mentioned farming-related crimes, such as stock theft and illegal grazing, at a relative frequency rate of 13% as other threats and risks of border security in South Africa.

Figure 6.6: Opinions of SAPS officials on the threats and risks to border security in South Africa.



In support of the above depiction, Participant 10 said the following about the most prevalent threats and risk to border security in his area of operation:

> "In my area of operation, the stolen vehicles, the stock theft, illegal movement of goods and persons, as well as borderline farming community employing foreign nationals into the country".

Participant 12 said the following about the threats and risks to border security:

> "For us it will be stock theft, stolen vehicles, illegal crossing, drugs…".

Moreover, Participant 13 stated:

> "The smuggling of contraband such as illicit cigarettes, illegal drugs such as dagga, the influx of undocumented migrants, and the movement of stolen or robbed vehicles out of the RSA".

From the outline above, there is a common understanding of the various threats and risks to border security at the various border areas in South Africa. There are commonalities in terms of the threats and risks across all the various border areas in South Africa, as indicated by the various participants in the category of border security officials.

6.3.1.2 Challenges of border security in South Africa

The five participants mentioned an array of challenges related to the monitoring and control of the borders in South Africa. The participants mentioned seven challenges related to the provision of effective border security in their respective areas of operation. The total number of sub-themes, which emerged from the predefined theme of the challenges of border security, was seven.

In addition, the overall frequency of the subthemes provided by the participants, as depicted in **Table 6.5**, was 17. The challenges mentioned by the participants related to aspects such as the border terrain and inadequate resources to control and monitor the borderline.

Table 6.5: Opinions of SAPS officials on the challenges of border security in South Africa

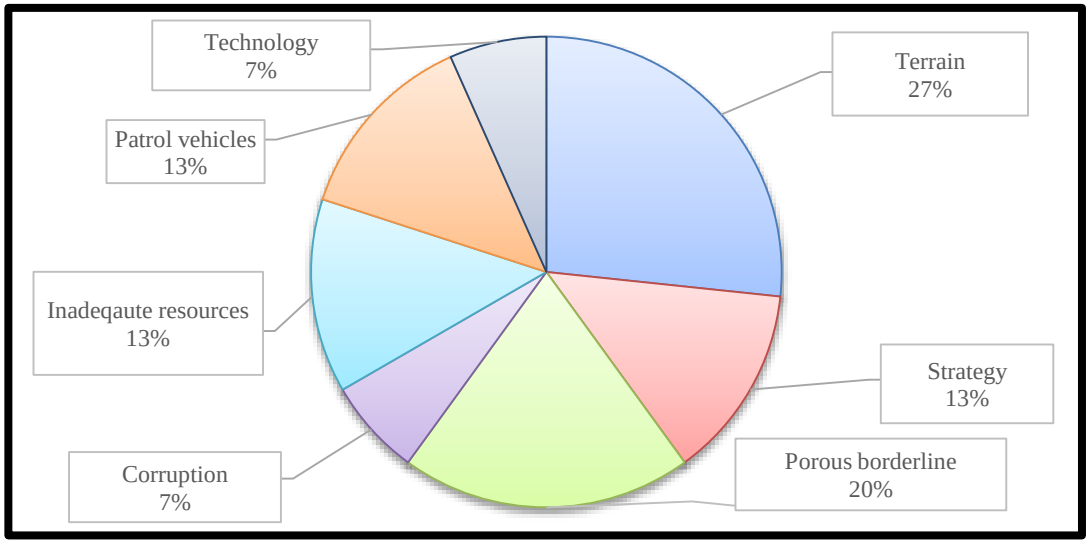
Challenges of border security	Frequency	Relative frequency
Terrain	4	0.27
Strategy	2	0.13
Porous borderline	3	0.20
Corruption	1	0.07
Inadequate resources	2	0.13
Unsuitable patrol vehicles	2	0.13
Lack of technology	1	0.07
Total	**17**	**1.00**

Considering the above, the challenge mentioned most frequently by the participants, as displayed in **Figure 6.7**, was the border area terrain and typology, which made it

difficult for border security authorities to patrol (27%). Other participants mentioned the porous borderline as a critical challenge. This challenge had a relative frequency of 20%.

Other factors, which were mentioned by the participants, at a frequency of 13% each, were the lack of suitable vehicles to patrol the borderline; inadequate resources to render effective border security; and the lack of sufficient border security strategy. Corruption and the lack of technology, each at a relative frequency of 7%, were also mentioned by the participants as challenges of border security at various border areas in South Africa.

Figure 6.7: Opinions of SAPS officials on the challenges to border security in South Africa



Considering the above analysis of the most prevalent threats and risks to border security in South Africa, Participant 10 said:

> "The challenges are the non-existence of borderline area, it's mountainous area and there's no fence, the borderline fence in our area".

In addition, Participant 9 stated:

> "You know the first thing is that the terrain, the borderline terrain… Lebombo borderline, it's all a mountainous area… it's based on mountainous areas – now to patrol the border, it's a challenge".

Moreover, Participant 12 opined:

> "Main challenge it would be the porous borderline… the unmaintained roads at the borderlines. Resources, human resources and vehicle resources are our main challenge. The roads there, but you can't travel on them even if we are using 4x4. They're not maintained actually".

The responses given by the participants suggested that it was often difficult to control and monitor South African borders due to unfavourable terrain. The participants also mentioned inadequate resources and vehicles, which were unsuitable for the border terrain.

The porousness of the borderline also made it difficult to provide the required levels of border security since illegal migrants are able to cross in and out of South Africa without any much hindrance. Similarly, criminal networks are able to execute their transnational criminal activities such as human smuggling, smuggling of stolen vehicles and other illicit goods, and livestock theft with relative ease due to several weaknesses in the border security architecture in South Africa.

6.3.1.3 Application of space technology to enhance border security in South Africa

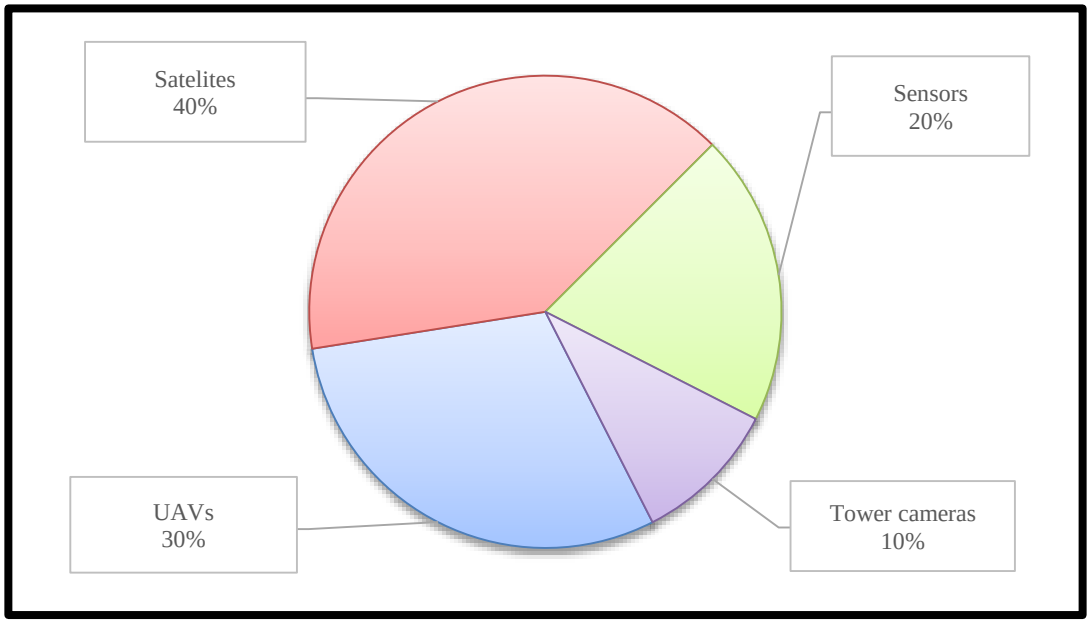
Members of the SAPS provided their opinions in relation to the use of space technology for enhancing border security in South Africa. All five participants concurred that space technology should be employed by border security authorities to enhance border security in South Africa. Some preferred different space-based technologies to others, each with varying reasons, such as costs implication. The total number of sub-themes, which emerged against this line of enquiry, was four. The sum of the frequencies of the subthemes mentioned by the participants against the main theme of space technology for border security was 10, as presented in **Table 6.6**.

Table 6.6: Opinions of SAPS officials on relevant space technology for border security

Border security space technology	Frequency	Relative frequency
Satellites	4	0.4
Sensors	2	0.2
UAVs	3	0.3
Cameras	1	0.1
Total	**10**	**1.00**

Some of the participants were in support of the use of satellite technology to enhance border security in the South African context. In terms of **Figure 6.8**, this proposed technology constituted 40% of the total border security technologies supported by all the participants in this research. Other participants supported the use of UAVs for border security in South Africa at a frequency rate of 30% of the total responses. On the other hand, two participants interviewed in this research supported the use of sensors to enhance border security in South Africa at a frequency rate of 20%. Lastly, one participant suggested tower cameras as another means to enhance border security in South Africa at a frequency rate of 10%.

Figure 6. 8: Opinions of SAPS officials on relevant space technology for border security



Considering the challenges experienced by border security authorities in monitoring and controlling South Africa's borders, the participants commented as follows regarding the role that space technology could play in enhancing border security in South Africa. Participant 13 said the following:

> "Space technology can be very effectively be employed in my area of operation to enhance border security. The mountainous area makes it difficult to reach or access long stretches of borderline… space technology can ensure that these areas are monitored and thereby enhance border security".

In support of the above, Participant 10 stated:

> "You can utilise the drones as well as integrated fixed tower with cameras. But, issue of drones and cameras, we can have a visual of what is happening in that particular area. The satellite is also included, as it will be giving us the physical space or the visual of where the issue is that it is happening".

Participant 9 supported the use of UAVs:

> "…and, we can't mention air patrols because now air patrols actually they are not effective. It's just like the road really, but we can utilise the air patrols where the use of drones they can be effective, they are cost effective, they are less expensive in terms of the funding, the drones".

Participant 9 further indicated that:

> "So now those they can be one of the modern borderline gadgets that can be used. And then we have the response teams that can help us to support towards a specific area and then we will be able to use it".

When asked what type of space technology would be the most suitable for border security in South Africa, Participant 13 said:

> "Satellite equipped with camera equipment".

Participant 10 supported the above participant by stating:

> "The satellite is also included, as it will be giving us the physical space or the visual of where the issue is that it is happening".

It can be noted that the participants preferred a variety of technologies to enhance border security in South Africa. The opinions provided by the participants indicated that various technologies, consisting of satellites, UAVs, sensors and radars, could be integrated to provide effective border security in South Africa.

Even in this line of questioning, some participants highlighted the difficulties they experienced in patrolling the borderline due to the unfavourable terrain; thus, highlighting the need to employ aerial technologies for border control and monitoring.

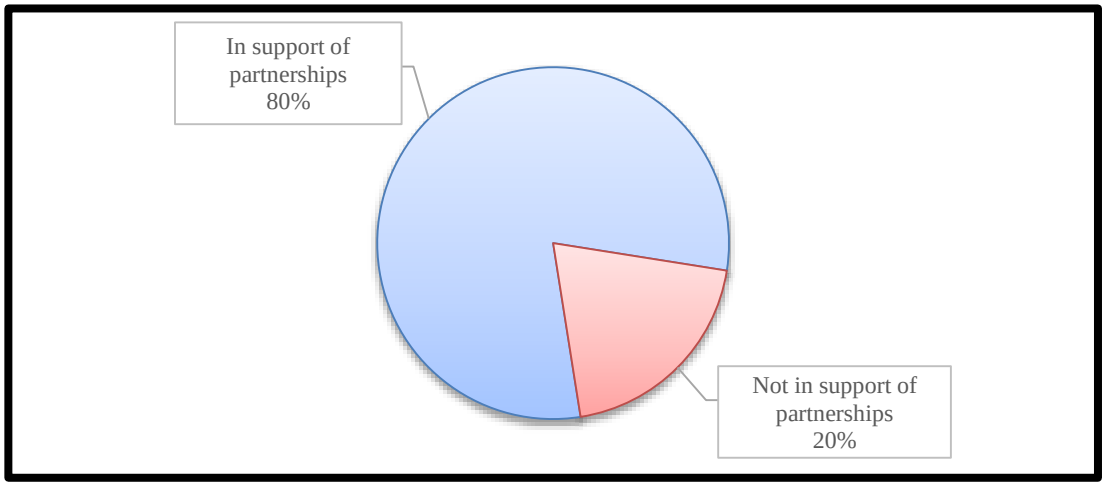
6.3.1.4 Public-private partnerships for enhancing border security in South Africa through space technology

All the participants presented their views on the possibility of involving the private technology sector for the enhancement of border security in South Africa through the development and deployment of space technology.

As displayed in **Figure 6.9**, almost all the participants were in full agreement that the private space technology sector could play a critical role in support of border security agencies to enhance border security in South Africa (80%) by assisting in the development and deployment of effective space-based border security technologies.

Only one participant was not fully in support of the idea of border security authorities in South Africa collaborating with the private space technology sector to provide effective border security through the application of space technology (20%).

Figure 6. 9: SAPS officials' views on partnerships



The researcher asked the participants whether partnerships between border security agencies and the space technology sector would be necessary to enhance border security in South Africa though space technology. In response, Participant 13 said:

> "Yes, it will be, for the benefit of the participants".

Participant 9 stated:

> "Now the partnership, the private people, is very crucial because now as the technologies they advance and everything… the government won't be able to or work with the technology but the partnership because they've got business interests to control".

According to Participant 10:

> "Yes, the partnership can be done but you know the data, the people, it will depend on how it will be instituted".

In contrast to the opinions of the other participants, Participant 11 said:

> "No, we can't have that organisation privately, yeah… If because the only people who are using the private zone are the people from south".

When asked what the opportunities of such a partnership would be, the participants mentioned a number of benefits. They mentioned benefits that could be derived by both the border security agencies and the private space technology sector. The potential benefits stated by the participants included technology innovation, enhanced border security, and the sharing of skills.

The participants provided six subthemes against this line of enquiry. The resultant frequencies of the responses provided by the participants were 12. **Table 6.7** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

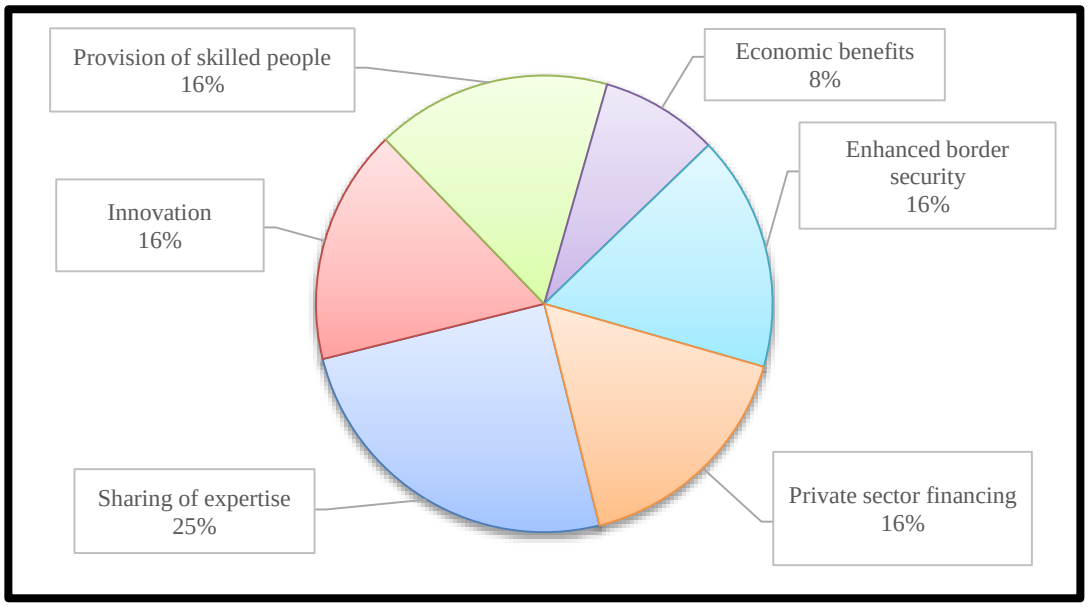
Table 6.7: Opinions of SAPS officials on the opportunities of PPPs for border security

Opportunities of partnerships	Frequency	Relative frequency
Innovation	2	0.16
Skills transfer	2	0.16
Economic benefits	1	0.8
Enhanced border security	2	0.16
Private sector financing	2	0.16
Sharing of expertise	3	0.25
Total	**12**	**1.00**

As indicated in Figure 6.10, the participants mentioned the sharing of expertise as the most mentioned benefit. This benefit had the highest relative frequency rate of 25%. The sharing of expertise was followed by the provision of skilled people by the private sector with a relative frequency of 16%.

Similarly, enhanced border security, technology innovation, and private sector financing, each had a relative frequency rate of 16% respectively. On the other hand, the benefit, least mentioned by the participants was economic benefits. This benefit with had a relative frequency of 8%.

Figure 6.10: Opinions of SAPS officials on the opportunities of PPPs for border security



In respect of the analysis above, Participant 13 said:

> "In this case, a space-based technology, which will need financial resources, people skills and expertise from the private sector, and will be an investment in the private sector, because it will ensure better border security by the border security agencies who are responsible for border security".

Moreover, Participant 11 stated:

> "But, can they be used to develop technology on behalf of… Yes, because the private sector got their own particular people… their own skills and all those."

Participant 12 added:

> "That is correct, if they can do that that will help us even because we don't have technicians actually, in our organisation (they could by) improving those things of space technology".

In general, the participants were in concurrence that it would be best to implement partnerships between border security authorities and the private space technology sector. The participants highlighted the enormous mutual benefits that could be derived from such partnerships. Following the above line of enquiry, the participants were also asked to identify the potential challenges of engaging the private space technology sector to enhance border security through the application of space technology.

The participants mentioned several challenges that could hamper the efforts to engage in effective partnerships. Issues, such as a lack of interest by the private sector, security concerns, and costs implications, were some issues for consideration mentioned by the participants. Five sub-themes emerged from this line of enquiry and the total frequency of responses, which were provided by the participants in relation to the potential challenges of implementing partnerships between border security authorities and the private space technology sector, was nine. **Table 6.8** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

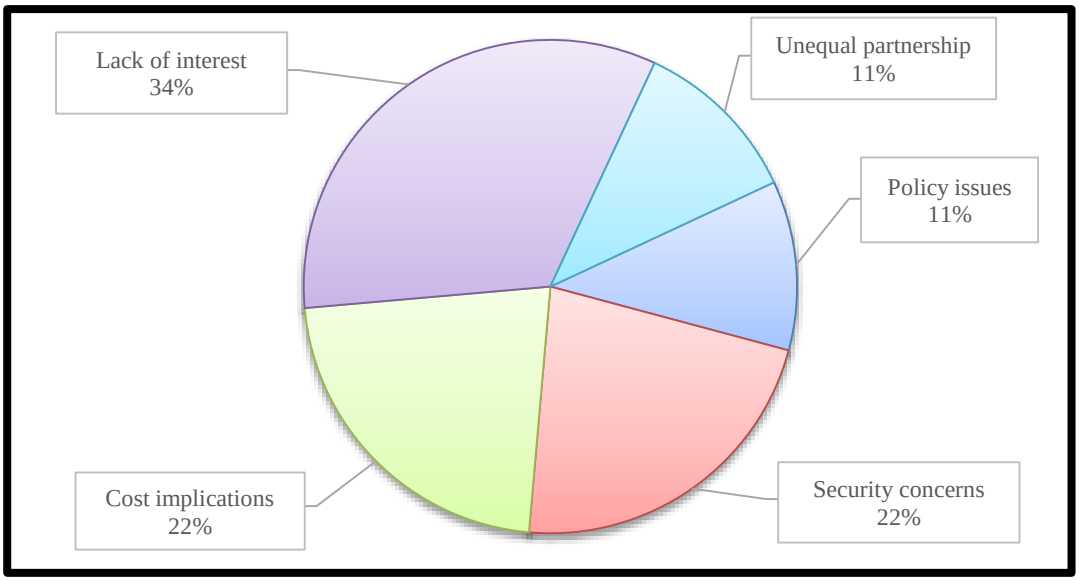
Table 6.8: Opinions of SAPS officials on the potential challenges of PPPs relating to border security.

Potential challenges of	**Frequency**	**Relative frequency**
Lack of interest	3	0.34
Cost implications	2	0.22
Security concerns	2	0.22
Policy issues	1	0.11
Unequal partnership	1	0.11
Total	**9**	**1.00**

As depicted in **Figure 6.11**, the participants indicated there could be a lack of interest from the private space technology sector to engage in such a partnership – with a relative frequency rate of 34%. Some participants said that such a partnership would create other security challenges, including compromising operational information. This factor constituted a relative frequency rate of 22%.

Other participants, also at a relative frequency rate of 22%, indicated that there would be huge cost implications for the public sector, which likely would prevent the public sector from entering into such an agreement. Moreover, the participants mentioned policy issues (11%) and unequal partnership (11%) as possible hindrances of implementing such a partnership.

Figure 6.11: Opinions of SAPS officials on the potential challenges of PPPs



On the potential challenges of forming partnerships between border security authorities and the private space technology sector, Participant 9 said:

> "Currently the policy… the policy, the police policy, actually will always remain with what do you call, the authority to decide… and then there's no 100 percent partnership by where a 20 percent can be taken. If you look at the country with the policy like the South African Police policy, yeah, but the police, they remain weak. The policy actually is not deployed were it is a fifty-fifty partnership".

Participant 13 highlighted some of the challenges involved:

> "The unwillingness of the public sector to go into such partnerships… there are not enough benefits for the private sector who financed and maintained such a partnership… the unwillingness

of the private sector to go into such partnership because of the substantial financial, technical and operational risk in the design, financing, building and operation in such a project".

Lastly, Participant 12 commented:

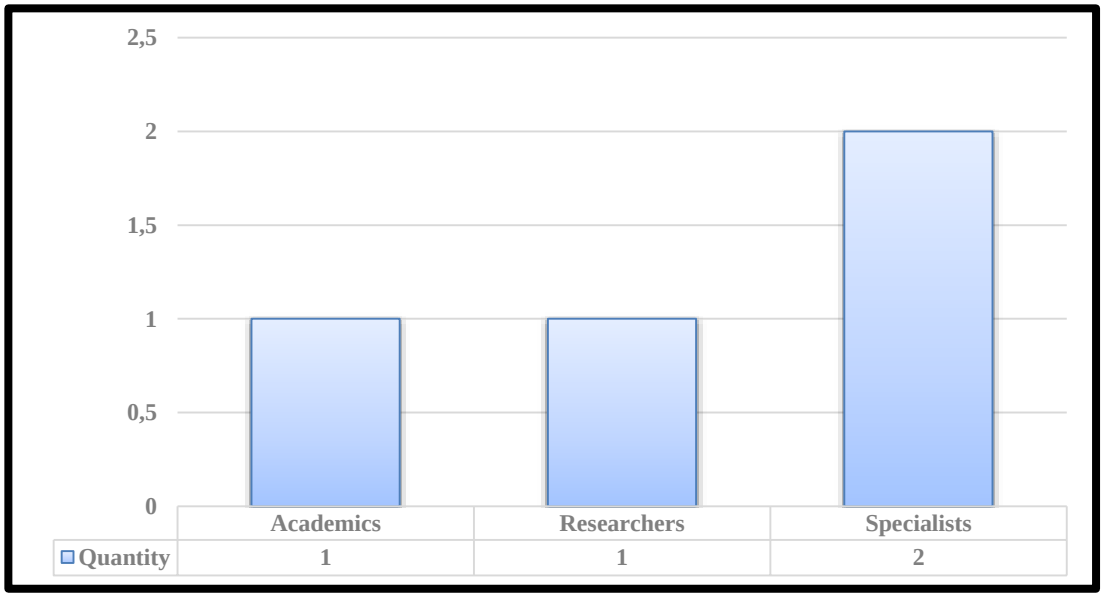
"So, it will be challenging based on budgetary constraints".

In this section of the research report, the researcher presented and analysed the responses provided by border security officials on the various lines of enquiries in line with the inter schedule. The next section of this research will present and analyse the responses of border security experts who took part in this research. The border security experts were drawn from various sectors of security.

6.3.2 Border Security Experts

Figure 6.12 shows that in this category of participants, four participants were interviewed by the researcher.

Figure 6.12: Categories of border security experts



The participants in this category consisted of border security experts made up of one researcher and one academic. In addition, other participants included two persons in which one was previously involved in border security with another one currently involved on operational matters of border security in South Africa. These participants were also interviewed using an interview guide. Due to their expertise in the field of border security, border security experts were also requested to provide their inputs independent of the interview guide. This allowed the researcher to gain additional information about border security matters in South Africa.

6.3.2.1 Threats and risks to border security in South Africa

Firstly, the researcher asked the participants to clarify what border security is. In providing a definition, all four participants defined border security a set of measures employed by border security agencies to prevent illegal cross-border activities. In this regard, Participant 1 defined border security in the following manner:

> "My understanding of border security is that there is borders; every time there's got borders and that borders needs to be secured. So, there's specific, I'm not saying agencies, but departments that are responsible for border security and in this regard, it is mainly now the SANDF that has to patrol the borders and safeguard the borders and then you have your formal structures and border posts that need to regulate the traffic, incoming and outgoing, the visitors to foreign countries and to South Africa. Because we saw in some areas an increase in farm attacks".

Participant 5 defined border security as follows:

> "For me a border security, it will obviously improve or is those measures that a country will put in place in order to safeguard or to protect its land, air and water. Remember a country, countries they differ".

In relation to the definition of border security, Participant 5 continued to indicate that:

> "For in case, South Africa we are lucky because we have land border, we have sea border, we have air border. But, other countries, they only have air border and sea border or water border, for instance. Most of the European countries, they don't have like a border with another country. But to come to your point at hand, border security in terms those measures, are placed to safeguard its land, and water obviously to detect any threats along those border... borders, whether it's a, it's a border line, whether it's a border post or ports of entry, whether it's a border crossing, whether it's a land port or a sea port. So, we're putting those measures to make sure that we safeguard our interest. Obviously again, against the illegal movement of people and, and goods in a nutshell. That's what border security is all about".

Participant 6 said the following about what border security meant to him:

> "Border security are the measures that a country puts in place to monitor and control its borders. This is done through the regulation of the entry and exit of people, animals and goods across a country's border. It aims at fighting terrorism and detecting the movement of criminals across the borders".

After obtaining clarity from the border security experts on what the term border security is in their own views, the researcher further asked the border security experts to highlight, according to their knowledge, the most prevalent border security threats and risks in South Africa.

The border security experts mentioned various threats and risks, such as migration-related crimes, smuggling activities, and farming-related criminal activities as the most prevalent threats and risks at South Africa's borders. The total number of subthemes, which emerged in this line of questioning, was five, with the total frequency of such responses being 19, as presented in **Table 6.9**.

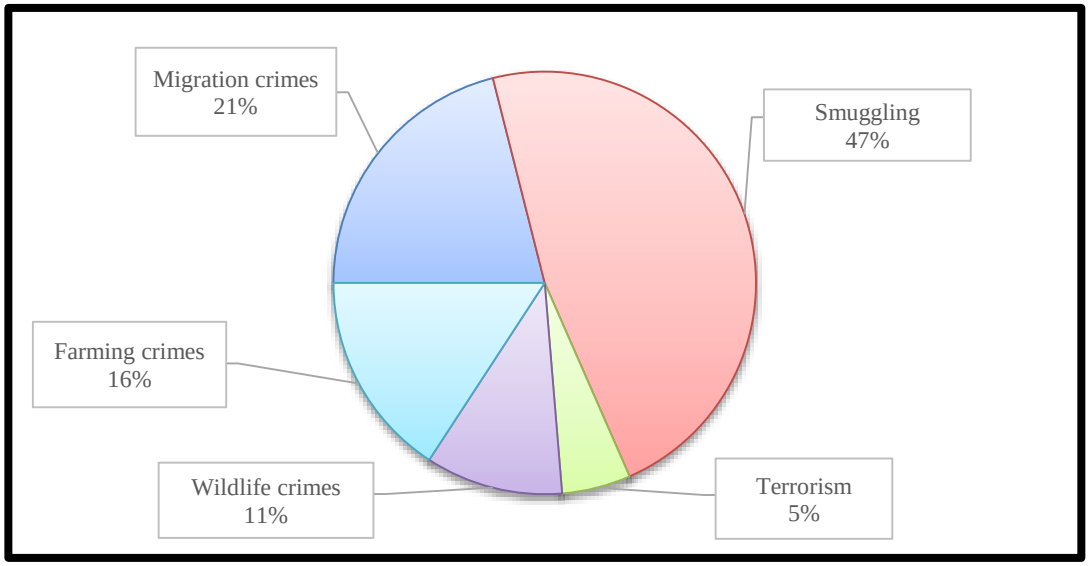
Table 6. 9: Opinions of border security experts on the threats and risks to border security in South Africa

Threats and risks	Frequency	Relative frequency
Migration crimes	4	0.21
Smuggling activities	9	0.47
Wildlife crimes	2	0.11
Farming crimes	3	0.16
Terrorism	1	0.05
Total	**19**	**1.00**

The threats and risks mentioned by the participants consisted of a combination of migration-related crimes, such as illegal border jumping and human smuggling (21%), as shown in **Figure 6.13**. Other participants mentioned a combination of smuggling activities, consisting of the smuggling of goods, explosives, and small arms (47%).

Farming-related crimes, such as stock theft and illegal grazing (16%), were further mentioned by the participants as some of the threats and risks. The participants also mentioned wildlife crimes (11%) and the possibility of terrorist activities (5%) as threats and risks to border security in South Africa.

Figure 6.13: Opinions of border security experts on the threats and risks of border security in South Africa



Considering the list above of threats and risks, Participant 6 mentioned the following in relation to the current border security threats and risks in South Africa:

> "The predominant forms of security threats include transnational organised crimes such as the smuggling of counterfeit goods, small arms and light weapons, explosives, illegal wildlife products and humans".

In support of the above, Participant 1 commented as follows:

> "Now what is happening is some of the Basothos are coming across the border because the Caledon River is the natural border fence and the river is currently dry, so they just cross the border illegally because there's almost 26 illegal crossing points that the SANDF have identified years ago and then they cross and they come and they attack these workers at the stock post and the farm and the farmers and whatever, their families... So, then other crimes that is very prevalent at the borders are stock theft where they come, and they steal huge amounts of cattle and sheep and they take them across the border. Then the illegal grazing also. They just chase the cattle onto farmland on the South African side and especially cattle and they just break the fences and cut the fences and there are lots of grazing here. It is to, it is a huge animal disease threat to the farmers".

Participant 2 suggested the following as border security threats and risks:

> "Now if I, if I either have to talk to social aspects. Now one of the threats against that, we'll obviously, we'll need the illegal movement or illegal migration…Now no country will allow people to illegally migrate to the country or come into a country because obviously it will have social economic ramification, I mean apparently, you can see in South Africa, we are complaining about a number of illegal foreigners that are here. Now that has an impact as far as our socio-economic systems are concerned. I mean, you've seen where people

> are complaining about foreigners taking our businesses, taking our work and all those things. So, even though not everybody has come to South Africa illegally, but there's empirical evidence that shows that a lot of people are here illegally".

Participant 2 further stated:

> "The second one would be obviously illegal importation or exportation of goods because people are illegally bringing goods into South Africa or taking goods out of South Africa illegally. They come to tend to lose much in as far as collection of actuals and taxes or duty taxes on those goods and services. So, given that, we ensure that there's no illegal importation or movement of goods… Now goods can mean anything. It can mean a lot of things, I mean from your smallest things to your biggest goods that you can, you can think of. I mean people are approaching, what do you call it? Ah, goods or your merchandise and all those things. So, it impacts negatively on the economy of of the country and also in terms of what government could have collected in terms of taxes from those. So, illegal importation, especially of goods, definitely, it's one, it's one of the greatest risks to South Africa, whether it's socially, whether it's economically or it's politically. That, they are. Other threats that are, I'm also thinking of, it's obviously organised, organised transnational crime… it is drug trafficking, trafficking, of trade binders between countries…".

The opinions of the participants on the threats and risks to border security in South Africa are similar to the opinions presented by the border security officials, as discussed earlier in this research.

Only one participant in the category of security experts mentioned terrorist activities as a possible threat and risk to border security in South Africa. This threat is also not adequately covered in available literature as a current threat and risk to border security in South Africa, although it cannot be ignored as a potential threat and risk.

6.3.2.2 Challenges of border security in South Africa

The participants indicated that South Africa has enormous challenges related to controlling and monitoring its borders. The participants opined that capacity constraints, infrastructural challenges, and an unfavourable border terrain were some of the challenges of providing effective border security in South Africa. Four sub-themes emerged from this line of enquiry.

In addition, the total frequencies of responses provided by the participants were 16. **Table 6.10** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants on the challenges of border security in South Africa.

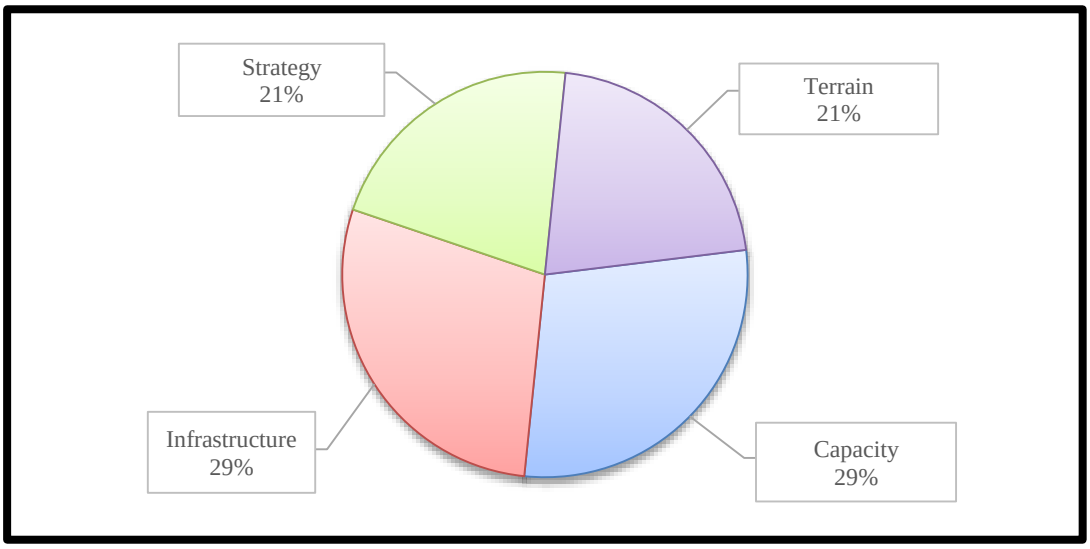
Table 6.10: Opinions of border security experts on the challenges of border security in South Africa

Role of the private sector	Frequency	Relative frequency
Capacity	4	0.29
Terrain	2	0.21
Strategy	2	0.21
Infrastructure	4	0.29
Total	**16**	**1.00**

According to Figure 6.14, the opinions of border security experts on the challenges of border security in South Africa were said to be capacity constraints (29%), caused mainly by underfunding. Other challenges mentioned by the border security experts were said to be the porosity of the borderline because of the lack of borderline infrastructure (29%); and poor border security strategy (21%).

In addition, the border security experts highlighted the unfavourable border terrain and typology (21%) which made it difficult to control and monitor the South African borderline as another significant challenge of border security in South Africa.

Figure 6.14: Opinions of border security experts on the challenges of border security in South Africa



On the challenges of border security in South Africa, Participant 1 commented as follows:

> "So, and then they-they do not have sufficient manpower. I think the two platoons, if you take the manpower there and you put the actual foot soldiers on the ground, then I think it will be two to three kilometres where, where there's one soldier and the next soldier, you understand? So, this is one of the biggest challenges there and then they don't have sufficient manpower and vehicles. They, I think that knowledge is one of the [inaudible: 00:11:53] that they need to introduce like drones and ah-ah and ja. We were [inaudible: 00:11:58] your questionnaire. But four, I think the police service, the police".

In support of the above, Participant 5 stated the following:

> "I think badly in so much as it the two main role players, which are the the Police, Border Police and the Defence Force are dramatically underfunded even though the Police themselves, I don't think are underfunded, they are massively… they have three times the funding

> of the Defence Force and they've got probably three times as many people".

Participant 5 continued to indicate that:

> But because of the way they're structured the, the, it does not cover across…very well. The Defence Force massively underfunded, that is largely the army, which is forced to deploy on the borders as part of its role, according to the Defence Act now. But because there isn't sufficient funding for them to do what they have to do it's, it's a massive problem and the degree of roles that happened in the Defence Force, the army particularly has to take over… It means that there is insufficient funding and personnel, never mind equipment to do the role properly".

Participant 6 stated the following:

> "Porous and poorly secured borders contribute to the problem. Large parts of the border fence and fence poles are stolen, there is a lack of capacity to monitor the long stretch of the border and the mountainous terrain in some areas is difficult to police. Furthermore, law enforcement lacks the capacity and resources to patrol and monitor the borders".

Participant 1 stated:

> "So, because the border is 485 kilometres long, and some of the areas is very mountainous, so it's difficult neh to patrol there… Now what is actually the big problem at our border is that there is no borders road".

As a general remark, Participant 1 held these views about the South African approach to border security:

> "No, I think, you know I think neh? If I can say, we are really, the farmers and the farming communities adjacent to the RSA Lesotho border, they are struggling, not for years, they are struggling for decades. It's decades, neh? So, I think now is really the time… It is the time to get to really be frank and be open and to say, I'm-I'm saying I think government has neglected their role and responsibility in providing an effective border security and safety… really. Um, it is my view, and I can be really not ah um the trusted on saying this or maybe I should, I can be wrong, but it's my perspective".

The responses given by the experts provide an indication of the critical challenges faced by border security authorities in providing effective border security in South Africa.

One critical element of border security, which was mentioned by the participants, is the lack or absence of a border security strategy. It can be deduced that without a properly formulated border security strategy it will prove difficult to render effective border security in South Africa.

Similar to the views of the border security officials, the security experts also mentioned that it is often difficult to control and monitor the South African borders due to the unfavourable border terrain. This aspect would necessitate the provision of suitable vehicles for border patrols or the deployment of aerial surveillance technology.

Inadequate resources, mainly because of the underfunding of the SANDF, continue to hamper the SANDF's ability to render effective border security in South Africa. This aspect was also widely reported on by the Minister of Defence in South Africa and senior members of the SANDF, as indicated in Section 6.2 of this study.

6.3.2.3 Application of space technology to enhance border security in South Africa

This line of enquiry sought to obtain the views of the participants on the extent to which space technology could be employed to enhance border security in South Africa. All

the participants agreed that space technology could be employed by the South African border authorities to enhance border security.

The participants mentioned a variety of space technologies that could be utilised for border security in South Africa. Important to note is that some participants mentioned that the deployment of a specific technology would depend on the border area. They mentioned technologies, such as UAVs, satellites and sensor, which could be integrated to in order to provide effective border security in South Africa.

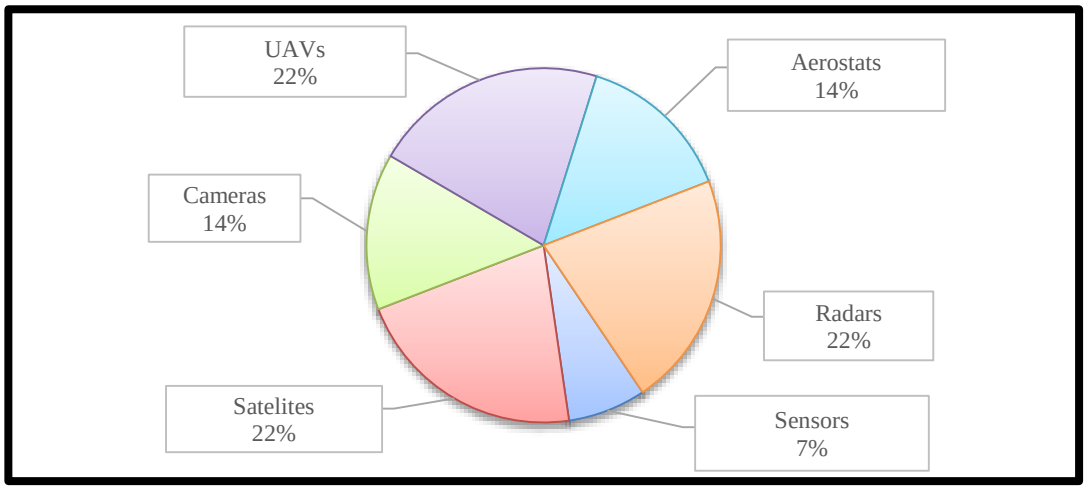
Six sub-themes emerged against the predefined theme of space technology for border security. The total frequency of responses provided by the participants in relation to the types of technologies was 14. **Table 4.11** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

Table 6.11: Opinions of border security experts on space technology for border security

Space technology for border	**Frequency**	**Relative frequency**
UAVs	3	0.22
Satellites	3	0.22
Cameras	2	0.14
Radars	3	0.22
Sensors	1	0.07
Aerostats	2	0.14
Total	**14**	**1.00**

Figure 6.15 indicates that the participants stated that technologies, such as satellites, UAVs and radars, each with a rate of 22%, could be employed by border security authorities to provide effective border security in South Africa. Other technologies mentioned by the participants which could be integrated with UAVs and satellites in order to improve the level of border security in South Africa were cameras and aerostats, with a relative frequency of 14% each, and sensors with a relative frequency of 7%.

Figure 6.15: Opinions of border security experts on space technology for border security



Regarding the analysis above, Participant 6 said the following on space technology:

> "In my opinion, these would be technologies such as drones to monitor borders and satellite to monitor location of criminal networks".

Similarly, Participant 5 stated:

> "Technology obviously, is a critical multiplier, with regards to their abilities, I tried years ago to get that at a very low level… to assist the army in deployments on the ground, but, and that required for example, putting up railway sleepers on certain areas where vehicles crossed the borders… But more, more importantly is the question of IT stuff like towers, radars, sensory equipment, satellite systems and so on… UAVs now particularly".

Participant 1 said the following:

> "You know what we also said or asked is that maybe they can install these long-distance cameras… Or radars or whatever, you understand... So that you can pick up early movement on the border, neh? Ah, but still you have to have reaction units available to react when you've picked up these movements, neh? But still, if it's

> connected to cell phone signals, then it will not work… It needs to be connected to space technology like satellites, you understand?"

Participant 2 also held the view that space technology could be applied for border security in South Africa:

> "So, you apply technology instead of, because as you are saying, you cannot always depend on conventional methods. You've got to also depend because if it, the border security, if you had to aggregate, it's a labour intensive… It's a lot of a human capital which may not have that luxury… our land border states, I mean it's huge… So, you can't have people patrolling that borderline on foot or so you want to minimise or minimise that by, by deploying technology. So, [inaudible: 00:23:53] technology, it's when you're employing technology to augment other conventional methods."

Participant 2 added:

> "I think, I will answer it by saying it will depend, it will depend on the type of the border or depend on the area that you need to secure. If it's, if it's for in case you, because I can see your study's more on land border… But, for a case, let's take a vast area like your border line, you can deploy civilian radars. I mean you can put civilian radars at strategic areas of the border where you are able to monitor or detect the movement of people, people who are trying to cross the areas, which are not designated as a border post or a port of entry".

On deploying satellites for border security, Participant 2 indicated that it would be difficult to deploy satellites for that function:

> "So, that can also help you; I mean, nowadays as you are aware of there are drones that are used, you can deploy drones, to patrol, to patrol the border line. The drones, it's cost effective to use compared to using a helicopter or… So, let's deploy drones to patrol and

> monitor and patrol, ja. Sure, it's difficult many times to put satellite there or surveillance cameras. That's why I'm saying you can put rather surveillance cameras, satellite cannot access – almost doing the same thing so…"

Furthermore, to the extent to which space technology could be employed to enhance border security in South Africa, the participants provided a number of benefits that could be derived from employing space technology for border security in South Africa. The participants mentioned four benefits of employing space technology for border security in South Africa.

Benefits, such as enhanced border security, proactiveness and the ability to utilise such technologies for multiple purposes, were important benefits mentioned by the participants. The participants also stated that depending on the border area, an assortment of security technologies could be employed to enhance border security in South Africa, which ultimately would bring about various benefits. The sum of the subthemes mentioned by the participants against the main theme of space technology for border security was four, as presented in **Table 6.12**.

Table 6.12: Opinions of border security experts on potential benefits of space technology

Potential benefits	**Frequency**	**Relative Frequency**
Proactiveness	1	0.17
Costs benefits	1	0.17
Enhanced border security	2	0.33
Multipurpose	2	0.33
Total	**6**	**1.00**

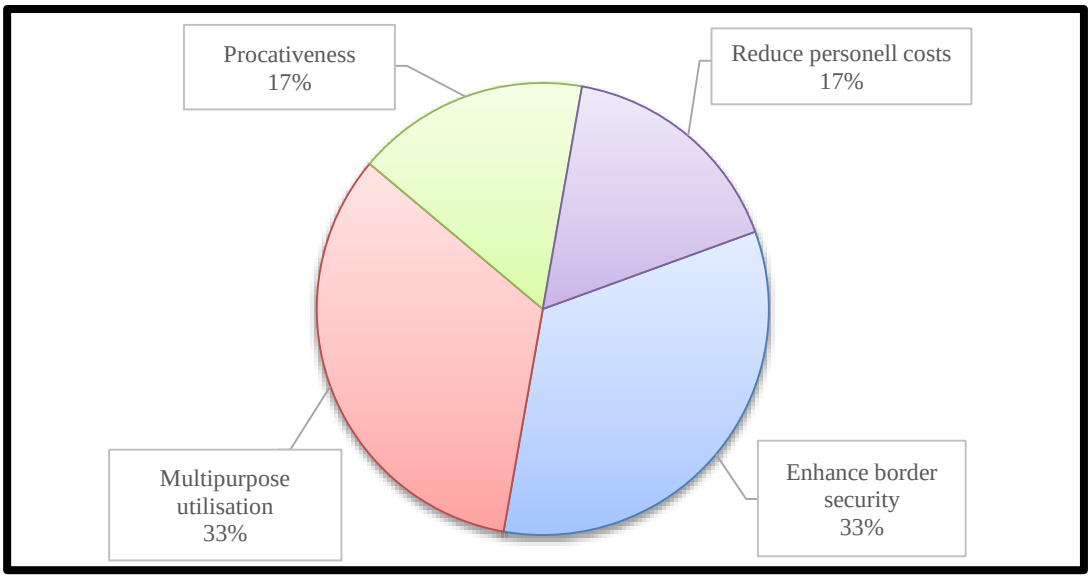
The participants mentioned that space technologies, such as UAVs and satellites, could be adopted by border security authorities to enhance border security in South Africa (33%).

One example mentioned by the participants in this research in relation to the use of space technology for border security in South Africa was that space technology would enable border security entities in South Africa to cover a wider border area as opposed to the current conventional methods of border monitoring, such as observation posts, vehicle and foot patrols.

Other participants in this research, as indicated in **Figure 6.16,** stated that space technology could be utilised for more than one function in the border security environment (33%), such as transporting supplies to border guards through UAVs, monitoring the flow of traffic into designated border posts, and monitoring veld fires in remote border areas.

The participants also said that space technology could offer proactiveness in the border security environment by being able to identify the risks before they reached the border and further alerting the authorities about the identified risks (17%). This aspect could also be linked to costs benefits by reducing the number of officials required for border security in South Africa.

Figure 6.16: Opinions of border security experts on potential benefits of space technology



Considering the various benefits of space technology for border security, Participant 2 said:

> "Well, my understanding of that concept, it's very touchy, technology that one can deploy through enhanced border security... It's a lot of human capital which may not have that luxury on our land border states, I mean it's huge… and that the, and the other one would be the active phase. Now in the proactive phase, you can deploy technology for situational analysis".

Participant 1 indicated that space technology, such as UAVs, could be used for a variety of functions in the border environment, considering that border areas in South Africa host many farming communities and those communities could benefit from the use of space technology. Participant 1 added:

> "But what I think is that it can be used in lots of things, neh? Why I, last year or the year before that we had the Young Farmers Congress, which that agriculture one, and then they actually… one of the keynote speakers addressed us on space technology in [inaudible: 00:24:49] and how they make sure that the farmers, the crops… the weather and how they can actually see whether your crops are growing and how to plant and to fertilise and to whatever, you understand"?

On the proactive and multiple roles that space technology could play in the border security environment, Participant 2 said:

> "But to come to a border security [in? 00:32:43] the ambit of security, if you've deployed those systems for weather, for situational analysis, if you're able to analyse what is happening in the border environment within the border line, the people crossing illegally, when are these things happening? Did it happen over weekends, do they happen at night and all those things, then we are able to plan properly or better…"

Participant 2 added that images captured by UAVs could be used as evidence in judicial

proceedings:

> "But, obviously it's a secondary road that can be played by technology. I mean obviously it will provide evidence because the evidence, it can provide evidence, in case of judicial processes. You do have that evidence whether it's video footage by a drone or by that driver or whatever you can call it, so you can use that evidence for it's secondary role because that's one thing we could play".

The participants were also asked to provide their insights on the possible factors that could inhibit the application of space technology for border security in South Africa. In this instance, the participants mentioned several factors that could inhibit the application in border security in South Africa.

The participants mentioned factors such as costs, regulatory issues, and the absence of technologically skilled employee as some of the potential inhibitors of utilising space technology for enhancing border security in South Africa. The sum of the subthemes mentioned by the participants against the main theme of space technology for border security was 13, as presented in **Table 6.13**.

Table 6.13: Opinions of border security experts on the possible inhibitors of space technology

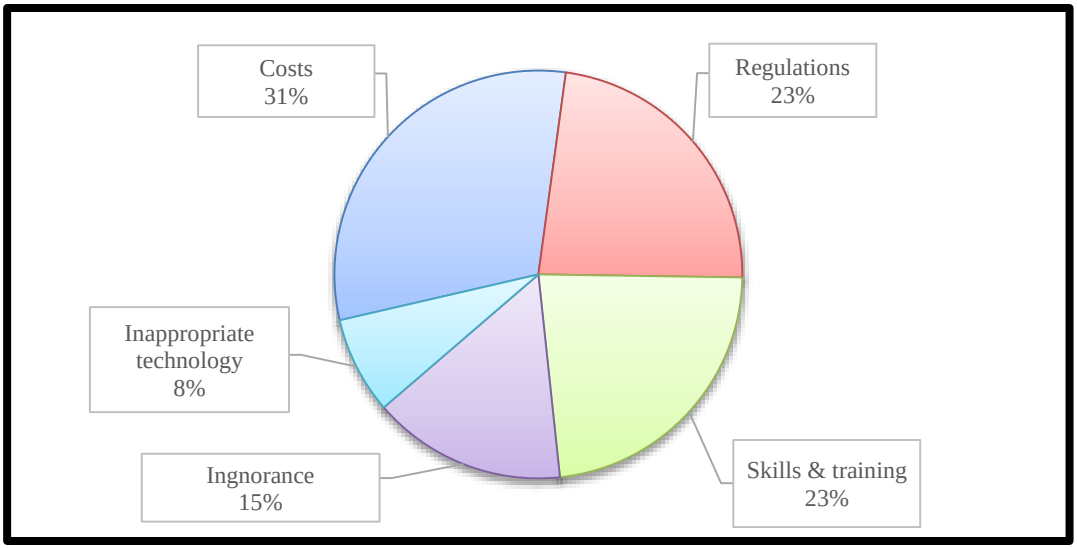
Possible Inhibitors	**Frequency**	**Relative Frequency**
Costs	4	0.31
Regulatory issues	3	0.23
Skills and training	3	0.23
Ignorance	2	0.19
Inappropriate technology	1	0.08
Total	**13**	**1.00**

The participants mentioned costs as the major potential inhibitor of employing space technology for border security in South Africa (31%). The participants also mentioned

legal requirements (23%) and lack of skills and training on the use of space technology (23%) as other potential inhibitors.

Other potential inhibitors mentioned by the participants were the lack of appreciation of space technology as a solution to border security challenges (19%) and the adoption of inappropriate technology (8%). This is indicated in **Figure 6.17**.

Figure 6.17: Opinions of border security experts on the possible inhibitors of space technology



Regarding the various potential inhibiting factors mentioned by the participants, Participant 2 made important comments:

> "So, as I've said, if you don't deploy the correct system, then it tends to defeat the whole purpose. It tends to defeat the whole purpose… also, I think other factors would be the appointment of what you call well-trained people. Because ja, if you appoint people that are not technology orientated, then that becomes a problem. That is going to be inhibiting because we deploy that technology, people want you to solve to remain useless."

Participant 2 continued to indicate that:

> "I think the other inhibiting factor there could be, as I've said, the underutilisation of the technology or the lack of upgrading because technology is evolving. So, we need to understand that if I put in a technology, so technology will evolve, so if I don't upgrade my technology, it's not going to work. I mean, in most of the borders there is technology but it is very old… Ah, it, that could be the legal imperatives because obviously there are certain legal imperatives that will prohibit everybody from getting from the same technology".

Participant 2 said the following on the utilisation of satellites for border security:

> "Sure. It's difficult many times to put satellite there or surveillance cameras. That's why I'm saying you can put rather surveillance cameras, satellite cannot access, almost doing the same thing so…"

In addition, Participant 1 said:

> "You know, I think it's one of the things is ignorance… Because I myself is not really informed about what it can do okay? I think it is not a cheap thing. I think it's an expensive thing, neh? But still, if you have a satellite or two in space, then ja, the maintenance is maybe high but whatever. But I think overall, if you look at the advantages of it, it can, and I foresee that it is much bigger than the disadvantages… So, but I think the thing about this is that I as a person is also ignorant about the-the advantages and what it can do, neh? In the benefiting of society and communities, neh? So I think a lot of government is maybe exploring this, but they are also not informed and ignorant, you understand".

On legal and regulatory constraints, Participant 1 had the following to say:

> "But you see the thing about… I hear what you're saying about flying drones and the legal issues about that. I think it's also at the beginning when it started, it was not well regulated… But it be, it

> became better regulated by CAA and also at staff and I think the SANDF as the prime [inaudible: 00:29:44] custodian of border security, they need to be equipped with drones and they need to have the ability to make use of drones in the border area".

On the potential inhibiting factors, Participant 6 asked the following questions:

> "…cost of purchasing the technology and operating it? Who will provide training for people to operate these technologies? Does the government have the capacity and funds to maintain these technologies?"

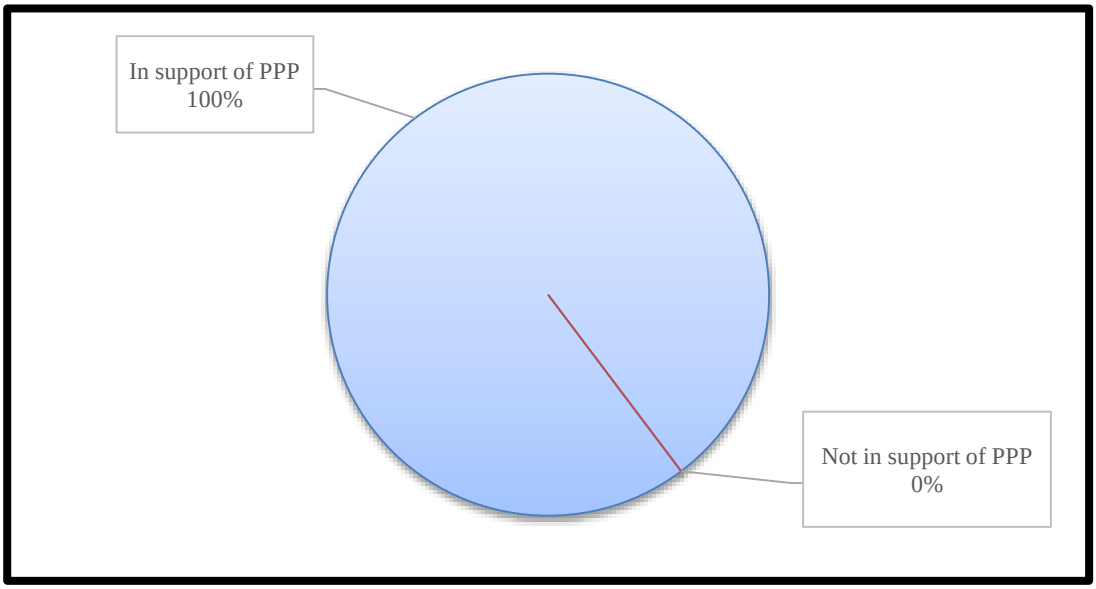
In this section of the research, border security experts provided their opinions on the extent to which space technology could be employed to enhance border security in South Africa. The participants also offered their opinions on the possible benefits of employing space technology. They further indicated that the deployment of space technology for border security would not be without challenges, which would have to be weighed against the potential benefits.

6.3.2.4 Public-private partnerships for enhancing border security in South Africa through space technology

All the participants agreed that there was the need for partnerships between border security authorities and the private space technology sector to enhance border security through space technology in South Africa. Furthermore, all the participants concurred that the private space technology sector could contribute to border security by providing border security entities with the necessary technology for enhancing border security in South Africa.

Figure 6.18 indicates that the participants concurred that the private space technology sector has the necessary expertise to support border security entities. They also said that the private space technology sector could provide technology innovation and develop technology, which was suitable for border security, and which could be integrated with other border security measures. They further mentioned that the role of border security entities would be to operate and maintain the technology.

Figure 6.18: Views of border security experts on PPP for border security



On the possibility and feasibility of establishing partnerships between border security agencies and the private space technology sector, Participant 6 said:

> "I think there exists more than a need - it should be a pre-requisite for such partnerships. The private sector would have the expertise and be responsible for training government personnel while the government and private sector be responsible for maintenance and operations. Government responsible for the operation and provision of the right candidates. Private sector, such as the technology industry, responsibility will be to assist government in this role".

In similar vein, Participant 2 stated:

> "Ja, indeed. Ah, I mean as you see, the private sector, they're playing a leading role in all these technological innovations. I mean definitely there's a [inaudible: 00:40:32] need. I mean currently there's that partnership between the private sector and the public sector as far as technology is concerned especially even in the border environment. I mean the developed technological deployed, which has been developed by the CS, CSIR, Denel, your Denel, your…"

Participant 1 commented with practical examples:

> "Now the Rural Safety Strategy is some sort of a public/private partnership… because they, organised agriculture, have taken hands with the SANDF and the SAPS".

Participant 1 further indicated that:

> "They can also become involved in this ADP. I know they had some sort of agreement with one of the satellite companies that they, what is that program, that they want to make use of Fidelity?"

Participant 1 continued:

> "Um, yo, I must just now think very hard, but they said they will launch two satellites with this, with this company so that they can also make cell phone coverage better, you understand? So, I think that is ja, that is a very big area that… I think the USA is one of the leading countries in the world where they utilise private/public partnerships, neh? If you can just think about the involvement of the private security industry".

In addition, the participants mentioned various reasons to engage in partnerships between the private space technology sector and border security entities for the enhancement of border security. The various participants mentioned benefits, such as enhanced border security, technological innovations, and return-on-investment (ROI), which could be derived from such partnerships.

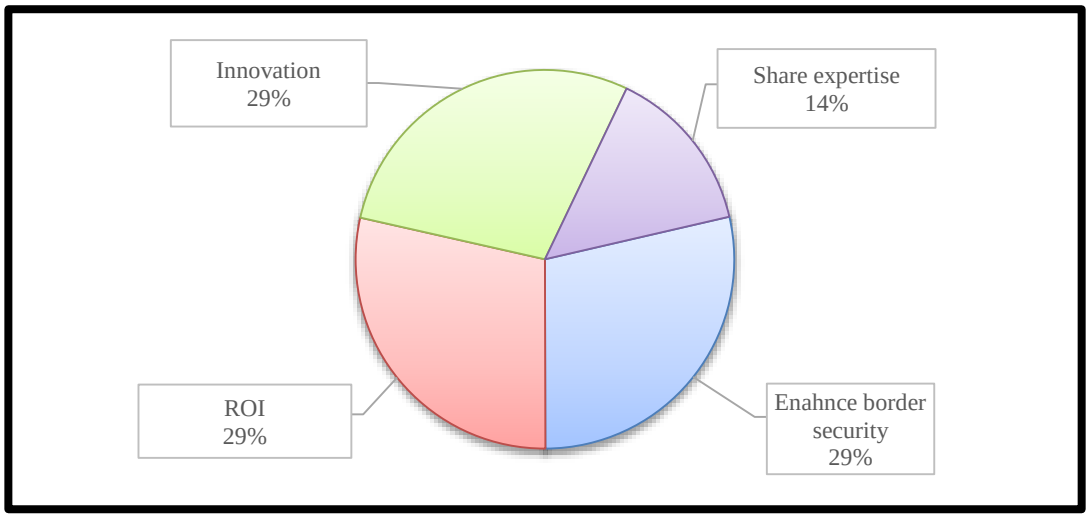
Four sub-themes emerged from the responses of the participants in line with the predefined main theme of the opportunities of PPPs. The sum of the frequencies of the subthemes mentioned by the participants was seven, as presented in **Table 6.14**.

Table 6.14: Border security experts' opinion on the opportunities of PPP for border security

Opportunities of PPPs	Frequency	Relative Frequency
Enhanced border security	2	0.29
Shared expertise	1	0.14
Innovation	2	0.29
ROI	2	0.29
Total	**7**	**1.00**

Regarding **Figure 6.19**, the participants indicated that partnerships between border security agencies and the private space technology sector could enhance border security in South Africa (29%). Similarly, other participants indicated that partnerships could yield a return-on-investment and result in cost benefits to the parties in the partnership (29%), while other participants indicated that the private space technology sector could facilitate border security technology innovation and development (29%). One participant indicated that partnerships could facilitate the sharing of expertise between the private space technology sector and border security entities (14%).

Figure 6.19: Opinions of border security experts on the opportunities of PPP



Participant 2 commented as follows on the opportunities of a partnership:

> "Look, well one of the opportunities will obviously be a return on investment because, ja. And secondly, it's the, it's a question of, it will, it will provide us I mean with the secure border environment. It will, I mean, if everybody is involved. You see the problem, without saying that, it's only government that is responsible for border security. But, I think it would be, it would be better if other stakeholders, especially different stakeholders, private, they are involved".

Participant 2 added:

> "Secondly, it's the, it's a question of, it will provide us, I mean, with the secure border environment. It will, I mean, if everybody is involved".

Participant 6 said a partnership would contribute to "shared expertise and cost benefit".

Participant 1 indicated that partnerships would enable the development of technologies that will result in proactiveness in the provision of border security:

> "So all these technologies that we need and will be used in order to be proactive – in order to create a proactive environment. I think it is really pertinent important, it's crucial that we try to become proactive and we can't expect nay a different outcome if we keep on doing the same thing. We need to be adaptable. We need to adapt to new technologies, and we need to make use of that new technology to our benefit".

Participant 2 indicated that the private sector plays a leading role in technological innovations. Thus, it would be important to engage them in partnerships:

> "Ja, indeed. Ah, I mean as you see, the private sector, they're playing a leading role in all these technological innovations. I mean definitely

> there's a [inaudible: 00:40:32] need. I mean currently there's, there's that partnership between the private sector and the public sector".

Participant 2 further referred to the involvement of entities of government departments, such as the CSIR, in the envisaged partnership:

> "As far as technology is concerned… especially, even in the border environment, I mean the developed technological deployed, which has been developed by the CSIR".

Despite the various opportunities and benefits of partnerships, as mentioned above, the participants argued that such partnership would not be without challenges. The participants mentioned that factors, such as funding challenges, corruption and mandate issues, were likely to hamper the effective implementation of partnerships. The sum of the subthemes, which were mentioned by the participants against the main theme on the potential challenges of engaging in PPPs to enhance border security through space technology in South Africa, was 11, as presented in **Table 6.15**.

Table 6.15: Opinions of border security experts on the potential challenges of PPPs for border security

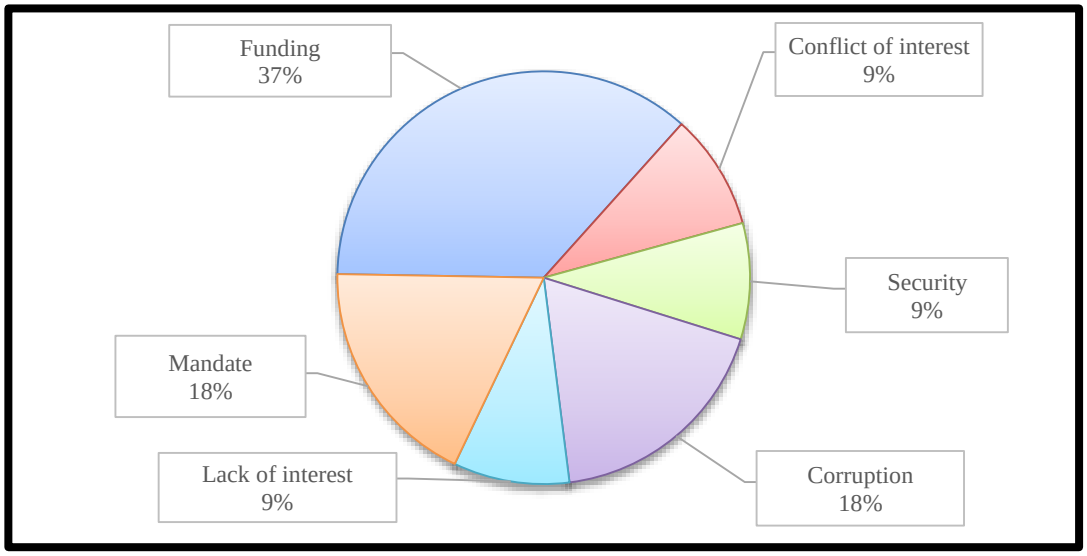
Challenges of PPPs	Frequency	Relative Frequency
Funding	4	0.37
Mandate	2	0.18
Lack of interest	1	0.09
Corruption	2	0.18
Conflict of interest	1	0.09
Security	1	0.09
Total	**11**	**1.00**

In analysing the opinions of the participants on the potential challenges of PPPs, as presented in **Figure 6.20**, the participants were concerned about the cost of engaging in PPPs and the associated funding challenges (37%). In addition, the participants were

concerned about corruption and an unclear mandate between the two parties in a partnership, with a relative frequency of 18% each.

Other participants mentioned a conflict of interest between the private space technology sector and border security entities (9%), and a lack of interest from the private sector (9%), as potential challenges of implementing the envisaged partnership between border security authorities and the private space technology sector in South Africa.

Figure 6.20: Opinions of border security experts on the potential challenges of PPPs



Participant 6 asked the following questions regarding the cost implications:

> "Cost of purchasing the technology and operating it? Who will provide training for people to operate these technologies? Does the government have the capacity and funds to maintain these technologies"?

On the aspect of conflicting interests, Participant 2 stated:

> "…and, under opposite of that, we know that there is a difference between the public sector and the private sector. One is service oriented, and one is profit oriented, yes. So, what could be the

> challenges that could inhibit effective public/private partnerships, especially in the context of border security and space technology?"

Participant 1 said the following on the mandate and the role of the contracting parties:

> "So, that's one of the biggest challenges to me in the formation of public/private partnerships. So the leading role player must be government, but I'm not sure whether it will ever be realisable… Ja so, but they, I think that is one of the biggest challenges there is that it needs to be well regulated and the mandate and responsibilities of every department and of every role player must be stipulated".

In similar vein, Participant 2 stated:

> "You see the problem, without saying that, it's only government that is responsible for border security".

Border security experts presented their expert views on the nature of the threats and risks facing South Africa. They also presented their views on the nature of the challenges faced by border security authorities in executing their border security mandate. On the deployment of space technology to enhance border security in South Africa, the participants were concurred that a number of technologies, such as satellites, UAVs, sensors and radars, could be integrated. The participants also supported the possibility of fostering partnerships between border security authorities and the private space technology sector to enhance border security through the application of space technology.

6.3.3 Unmanned Aerial Vehicle Specialists

In this category, four participants were interviewed by the researcher. The participants in this category consisted of UAV experts. The researcher focused on two main themes, namely, the extent to which UAVs could be utilised for border security in South Africa; and the role the private UAV sector could play in the enhancement of border security in South Africa. Thus, the aim was to address the following research questions:

- Research question 3: To what extent can space technology be applied to enhance land border security in South Africa?

- Research question 4: To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

6.3.3.1 Application of space technology (UAVs) to enhance land border security in South Africa

In the opening of the interview session, the researcher asked the participants to provide an expert definition of the term UAV. All four participants defined a UAV as an aircraft that could be piloted remotely without a pilot onboard. Considering this synopsis, Participant 8 defined a UAV as:

> "Any vehicle that would be travelling in the air, which has no physical person in it. It is either controlled remotely by a person, and/or with onboard autonomous systems, and/or remote autonomous systems".

Participant 3 defined a UAV as follows:

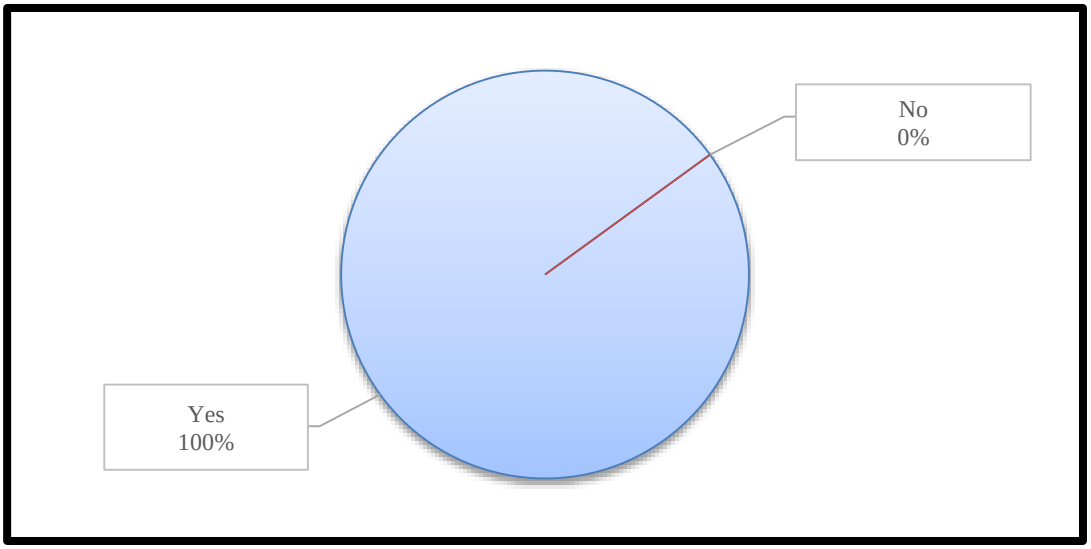
> "Look, the unmanned aircraft vehicles, as I'm on the official, well, it is a legislated terminology for that it's unmanned aircraft systems right, and then that's an overarching, overarching name, and then under unmanned craft systems, then you have what we refer to as remotely piloted aircraft systems alright. Then, under like I said, the unmanned of systems would be overarching and then under that you have remotely piloted aircraft systems commonly known as RPAS, and then you'll have model aircraft; your model aircraft as well a subset of unmanned forces and, if you... so I... model aircraft being a big part of aviation previously since 1920".

Participant 7 provided the following definition:

> "UAV is any aerial vehicle which is piloted either remotely by a human or by a technology being either Artificial Intelligence or hardwired technology such as radar".

Subsequent to the various definitions of a UAV, as provided by the four participants, the researcher asked the participants whether UAVs could be used in border security activities in South Africa. In this regard, all the participants in this research, as presented in **Figure 6.21**, agreed that UAVs could be used for various border security activities in South Africa (100%). None of the four participants in this research disagreed with this notion (0%).

Figure 6.21: Opinions of UAV specialists on the use of UAVs for border security



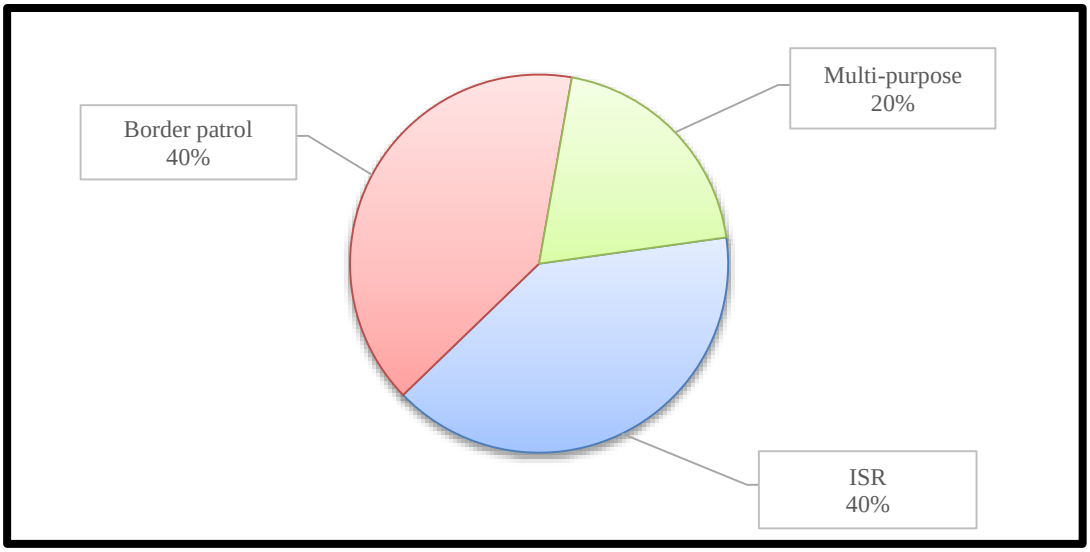
The participants were further asked about the possible role of UAVs in the border security environment in South Africa. In their responses, the participants provided a few critical functions that could be performed by UAVs in the border security environment in South Africa. The participants said that UAVs could be used for a number of functions, including for border patrols, and Intelligence Surveillance and Reconnaissance (ISR). Hence, the total number of subthemes, which emerged herein, was three. **Table 6.16** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants, which was recorded as eight.

Table 6.16: Opinions of UAV specialists on the use of UAVs for border security

Use of UAVs for border security	Frequency	Relative Frequency
Border patrol	4	0.4
ISR	4	0.4
Multiple purposes	2	0.2
Total	**8**	**1.00**

In line with **Figure 6.22**, the participants were of a view that UAVs could be used for ISR missions in the border security environment in South Africa (40%). The participants also said that UAVs could be used for border patrols (40%). The participants further said that they could be used for multiple purposes in the border security environment (20%), such as transporting supplies to border agents on patrol in remote border areas.

Figure 6.22: Opinions of UAV specialists on the use of UAVs for border security in South Africa



Considering the possible utilisation of UAVs, as depicted above, Participant 7 indicated that UAVs are being use in border security by some countries globally. This is linked to the fact that UAVs have low running costs and cover vast areas, as opposed to conventional methods of controlling and monitoring borderlines, such as on foot and in vehicle patrols. The participant further stated that when equipped with thermal

cameras, UAVs are able to detect and monitor events in the border area. Another benefit of UAVs is that they can be used to deliver supplies to border guards.

> "UAV technology specifically brings vast benefits beyond standard border patrols as they cover vast distances and have the ability to carry vastly different payloads for border patrol, specifically thermal cameras, optical cameras or LiDar linked to Artificial Intelligence or analytics to detect events. Another added benefit is cost – UAV deployment is extremely low-cost comparative to Standard Patrol Aircraft. To add additional benefits, UAV can be used to deliver critical components/medical supplies and food parcels to border patrols".

As with Participant 7, Participant 3 said that a payload could be attached to a UAV to carry out a number of activities, such as cameras for data collection and monitoring events in the border area, and security surveillance.

> "I mean, a typical operation is basically any operation where you need to, let's say, you gather data… Or this would be where you have some kind of payload that you're going to attach on the aircraft system, and the payload would be anything that you put on that drone for a particular purpose, like payloads, like a camera might be a payload…You know you could hook there, maybe; you can hook a sling on that drone to maybe lift, you know, an items off from the ground".

Participant 7 continued to state that:

> "So, typically, I mean, if I look in South Africa, most typically uses are for security surveillance and for mining operations and then mostly under mining operations they use them for surveying or mapping or calculations and then you can have for all sorts of, for different corporations in South Africa. Like filming industries, they use drones basically. You have farming, you know for smart farming,

> they use it for those and then the other ones would be... So, there are really different ways how drones are used or could be used".

Participant 14 held similar views, indicating that UAVs could be used for intelligence gathering, security surveillance, and reconnaissance; thus, allowing border guards on the ground to respond to activities detected by UAVs in the border area:

> "In an ISR role – Intelligence, Surveillance and Reconnaissance. Borders can be remotely monitored by UAV and ground forces can be called out to hotspots in real time".

Participant 4, who is a satellite technology specialist, highly supported the use of UAVs in border security as compared than satellites. The participant indicated that the use of UAVs in border security would be more effective and could be fitted with cameras that could be used at night:

> "You know, it's a thin line you know. You are going to need a very high resolution, I mean, one solution for, for border security would really for me be with the UAVs. Having UAV's roaming around that thing. That would be able, I know there are some cameras that can see the strokes on a Kudu at night… from you know 100 metres away, kind of whatever altitude they're flying at. They that would certainly be a much more effective…"

In the process of data collection, it was important for the researcher to understand the limitations that could come with the utilisation of UAVs for border security in South Africa. In this regard, the participants mentioned some limitations of UAVs, including operating costs, flight time, and regulatory issues, which could act as potential inhibitors to deploying UAVs for border security in South Africa.

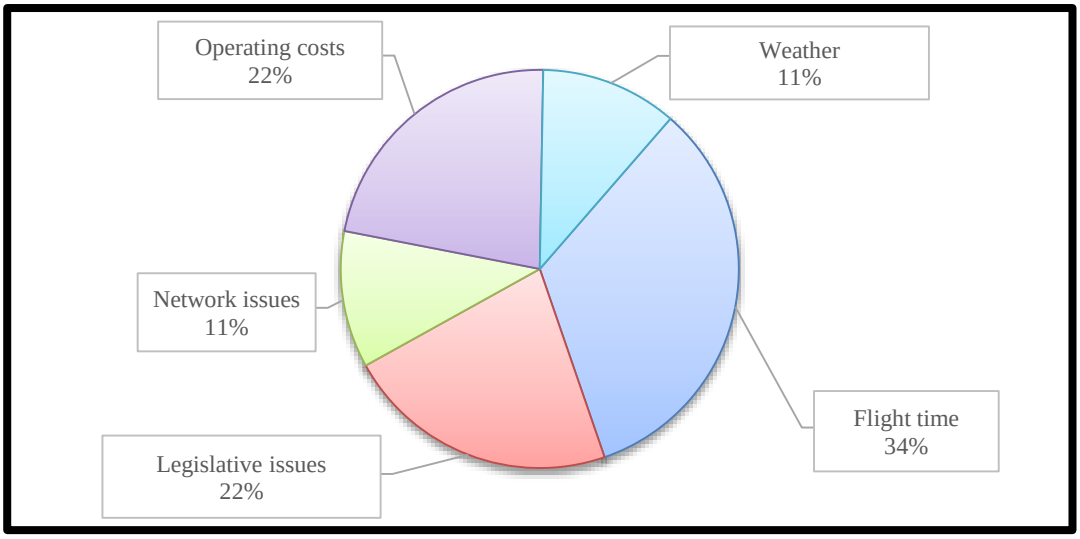
The number of sub-themes that emerged was five, whereas the total frequency of responses provided by the participants in relation to the potential shortfalls of UAVs were nine. **Table 6.17**provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

Table 6.17: Opinions of UAV specialists on the limitations of UAVs for utilisation in border security

Potential shortfalls of UAVs	Frequency	Relative Frequency
Operating costs	2	0.22
Weather	1	0.11
Flight time	3	0.34
Network issues	1	0.11
Regulatory issues	2	0.22
Total	**9**	**1.00**

Figure 6.23 indicates that flight time (34%) was mentioned by the participants as a major potential limitation. The participants also mentioned operating costs and regulatory issues (22%) as other potential challenges of employing UAVs for enhancing border security in South Africa; while, network and adverse weather conditions, each with a relative frequency of 11%, were also regarded by the participants as potential limitations.

Figure 6.23: Opinions of UAV specialists on the limitations of UAVs for border security



On the potential limitations of UAVs in terms of for border security, Participant 8 commented on the cost implications of deploying UAVs for border security. These cost

implications consist of the funds needed for research and development, the training of pilots, and accommodation for UAV operators and other technical staff.

> "Funds are needed, to be able to research and develop the UAVs that are specifically needed in South Africa (South Africa has other types of border security issues compared to other countries, so we cannot compare SA's border security with other countries that use UAVs, as there are different challenges). Then pilots will need to be qualified, and they will be needed to be stationed, and be able to live near the border. Maintenance and technical people will be needed to be located there too".

Participant 7 said that the flight time of UAVs needed to be considered when deploying drones for border security and, more importantly, communication or network challenges because most border areas in South Africa are located in remote areas. Network challenges would limit the transmission of data, such as live video images, to ground operators and the central command station:

> "In looking at any UAV deployment there are a number of considerations, namely fly time distance and communication in South African terms. Our borders are not only land but sea. The limitation would be purely video/payload broadcast distance in many cases. Commercial drones/UAVs have a video broadcast limit of 150 to 200 km without repeaters, so in the case of South African a repeater network would need to be deployed".

Participant 3 held a similar view, indicating that UAV flight time would be one of the disadvantages of deploying drones for border security. The participant added that severe weather conditions would also affect the operation of UAVs:

> "Ja, challenges that would be your biggest challenge, the flight time. That's because with drones, I mean typically, you will get ja, let's say three, I've never seen one that can go four hours, but most probably they might be there but there is a limitation of your flight time; one

> of the biggest challenge for me in the industry with drones is inclement weather. Most drones are not able to fly, you know, when it's raining or high wind, you know, such. So, those are, I would say, those would be the biggest challenges that you'd have and ja".

Participant 3 added:

> "On the technology side I think that would be that, from my point of view, one of the challenges that you might have is I mean drones are regulated. Operations of drones are regulated. So, one of the challenges that you might have, obviously may be civilian rules or are you going to follow military rules. So, but on the civilian rules, the civilian market shall be one of your biggest challenges".

The same participant recommended that military grade long endurance UAVs could be deployed to cater for the limitations of civilian drones, which are mainly used in security operations:

> "Long endurance drones, typically you'll find them in military operations. Right, but most of civilian drones, like I was saying maybe three, four at most five hours. But, for real endurance you might be able to find drones that can fly for up to 12 hours. But, those would be military grade type of drones".

Participant 14 named the current regulatory framework in South Africa as a possible inhibitor in the use of UAVs for border security:

> "Current CAA regulations will inhibit full potential of UAV border patrol".

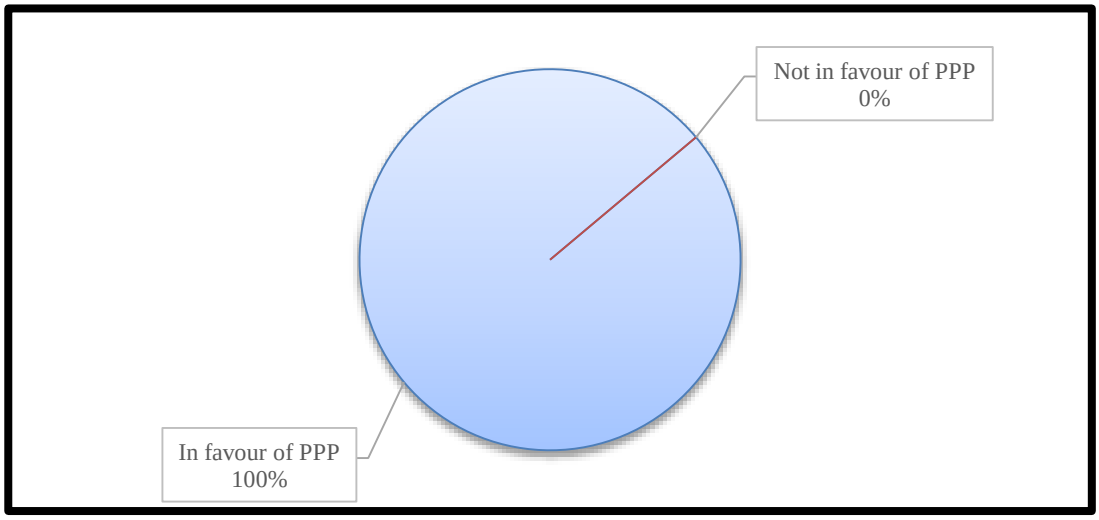
The participants supported the utilisation of UAVs for border security in South Africa. They also provided the benefits of employing UAVs for border security in the country. Moreover, the participants provided their opinions on the potential limitations of using

UAVs for border security. The next section will explore the possibility of establishing PPPs to enhance border security through the utilisation of UAVs.

6.3.3.2 Public-private partnerships for enhancing border security in South Africa through space technology

All four participants defined PPPs as an agreement or arrangement between the public sector and the private sector to provide certain services and goods. Moreover, all four participants, as shown in **Figure 6.24**, agreed that there could be partnerships between border security agencies and the private UAV sector in the provision of technological solutions to enhance border security in South Africa.

Figure 6. 24: Opinions of UAV specialists on PPPs for enhancing border security.



The total number of sub-themes, which emerged against this line of enquiry, was seven. The participants mentioned that partnerships between border security entities and the private UAV industry for the purpose of enhancing border security in South Africa could yield several benefits for both parties to the envisaged partnership. The participants also stated that both parties in the envisaged partnership could contribute positively to the envisaged partnership.

The participants interviewed in this research mentioned various benefits consisting of market development, the integration of systems, economic benefits, as well as

efficiency as some of the benefits that could be derived from effective partnerships between border security agencies and the UAV industry in South Africa.

The total frequency of responses provided by the participants in this research in relation to the potential benefits of adopting PPPs for enhancing border security in South Africa through the application of space technology were 19. **Table 6.18** provides the frequency of each subtheme mentioned by the research participants and its frequency relative to other subthemes mentioned by the same participants in this research.

Table 6.18: Opinions of UAV specialists on the benefits of PPPs in enhancing border security.

Potential benefits of PPPs	Frequency	Relative Frequency
Market development	3	0.16
Integration	3	0.16
Research and development	2	0.10
Enhanced border security	3	0.16
Economic benefits	4	0.21
Efficiency	2	0.10
SME Development	2	0.10
Total	**19**	**1.00**

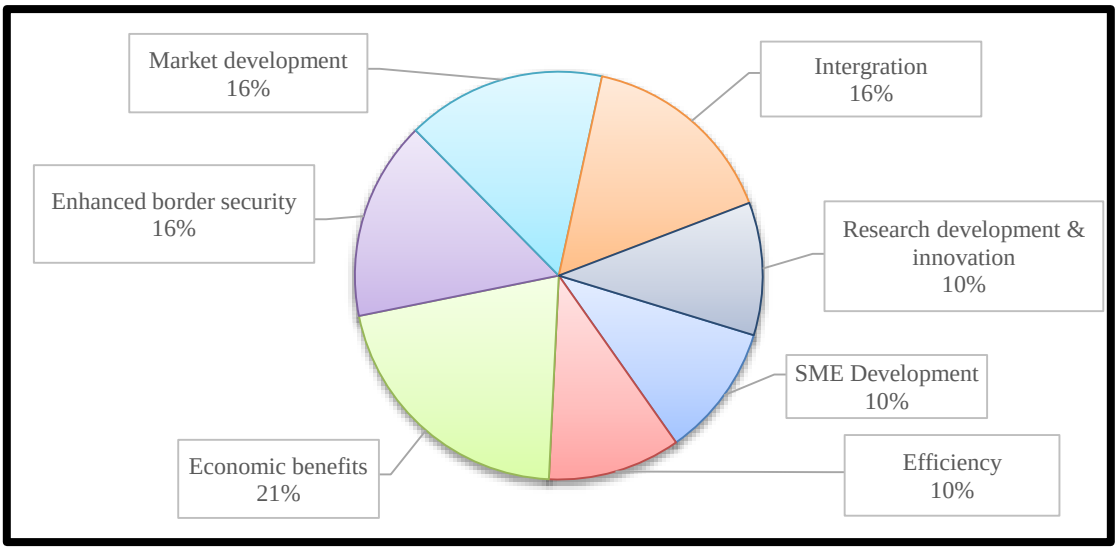
As presented in **Figure 6.25**, the participants concurred that partnerships would enhance border security (16%). Some participants indicated that partnerships would improve markets development of the UAV industry (16%), while other participants cited economic benefits (16%) as a potential reward of effective partnerships between border security entities and the private UAV industry.

In addition, the participants indicated that partnerships would result in the integration of systems among the various actors in the border security environment, including farming communities and nature reserves (16%).

Other potential benefits mentioned by the participants were SME development (10%), and research, development and innovation (10%). The participants further said that

partnerships would result in efficiency in the delivery of technological products (10%) and reduce the human resource costs associated with border security (10%).

Figure 6.25: Opinions of UAV specialists on the benefits of implementing PPPs for border security.



Considering the aspects of research, development, innovation and economic benefits, Participant 8 said that partnerships would result in the effective marketing of UAVs and in cost benefits for both the partners in the partnership. The participant also opined that the private sector would be better positioned to identify the necessary research and development needs and be able to supply what was needed by the public entity for a specific mission such as border security:

> "There will be a need for this partnership. This happens even in the manned aircraft industry. Companies such as Starlite Aviation have been training Kenya air force pilots with an agreement that will benefit both parties, in terms of costs, marketing, and a consistent cash flow. Similar with UAVs, this approach will be needed. As mentioned above, this approach will be required in the research and development, as the private sector will need to identify the research and development of the UAVs, but will need to know that there will be a market for it and that these UAVs will be able to give them an income".

Participant 8 further indicated that:

> "The public (government, and other entities) will need to get the UAVs, negotiate with companies such as Starlite Aviation on the ROC and other documentations that are needed to have the UAV legally in the air (they have already systems in place to prevent people having to wait for two+ years for documentation to be validated by the CAA, and identify what is required in the different missions. There is also Aerspace-3D that is involved with obtaining reliable UAVs and equipment, which are not sourced locally".

Participant 7 provided a number of potential benefits associated with the adoption of partnerships between border security authorities and the private sector. The participant suggested that partnerships would improve the provision of border security in South Africa, further suggesting that such a partnership would result in economic benefits through SME development:

> "By all means government would like to think it has resources to protect our borders but quite frankly are lacking in a number of areas. The current lack of service delivery of the most basic services to the public is evidence as such. A PPP would really allow for service delivery, which would in my belief directly affect the economy and should it be driven through SME development, for example, a dedicated airspace (200km) and deliverable from the SME to government of situational awareness and communication to border police would immediately affect the economy. Private sector technology and service delivery to border police and the SANDF. Public (government) Funding for SME in this arena".

In support of the above assertions, Participant 7 also indicated that effective partnerships between border security entities and the UAV industry would result in improved border security. The participant further indicated that the envisaged partnership would reduce border security costs, particularly personnel related costs. Other benefits of partnerships mentioned by this participant were the creation of jobs

and the efficient provisioning of border security assets by the private sector due to financial incentives that might arise because of partnerships with the government:

> "There are a number – tighter border control, crime prevention, situational awareness, lower costs on border patrol, immediate SME and local financial benefit. Each UAV station would create jobs and strengthen South African pride. You know as I've hinted simply because once as you like as government you express a need; you express the need, a requirement, you know, I mean private entities are always ready. You know, to solve problems. To solve issues because they are money driven. So, if you express a need and there's money involved, you know, we get that technology as soon as tomorrow. So, so your development period and implementation will be much, much quicker when you have such a relationship".

Participant 8 held similar views about the enhancement of border security through effective partnerships:

> "Overall, the advantage will be that border security will be improved, and it will not be just a 'pie in the sky' type of thing".

In support of these assertions, Participant 3 indicated that the application of border security through effective partnerships would work better:

> "My understanding with that is where you have the kind of relationship with working relationship between a government entity and a private entity and in my opinion, that's quite important, and as a matter of fact I think for most countries where they successfully deploy drones. So, any kind of technology, you know once that relationship has been defined and understood between two parties it can actually work much better".

A participant 14 indicated that the private sector would bring efficiency in the provision of suitable technologies for border security. The participant further said that the public

sector has a reputation of being slow in the provision of services. Therefore, it is important to source the services from a private partner to ensure efficiency:

> "The state is notoriously slow in making things happen. Private initiatives will shorten lead times and improve efficiency".

Participant 3 indicated that the private sector would bring innovation, as it is the forerunner when it comes to technology innovation. In this instance, the government will specify its needs and the private sector will deliver the required technology assets based on the needs of the government or the public authority:

> "When we talk about our capabilities right and typically, if you compare between let us say government or a private entity, government, public entity and government, and private entity. Always private entities are at the forefront of innovation. So, and for that to happen effectively, most of the time is when there's a need; when there's a requirement. When there's someone who's going to use that technology and most of the time that comes from government entity".

Participant 3 continued to state that:

> "Like in this instance when you talk about border management, border management, you know. From a government point of view, you'll express your need. You'll express, you know what is it that you require; how it must be achieved and then for to realise that, you know, government on its own it will be very difficult because as I've indicated generally government is not, you know, in a business of innovation or emergent technology and all that. So, those two capabilities now need to come together. You know, with government saying here's a need, here's a requirement and private entities say this is how we're going to meet that need".

Participant 8 said that there was also the need for a partnership between public and private nature reserves:

> "There will also be a need for partnership between the public and private nature reserves, which often border the SA borders. There will be a need for farmers and the community to be involved, and maybe there is an incentive if they assist".

Although there were potential benefits of partnerships between border security authorities and the private UAV sector, the participants also identified potential challenges in the establishment of partnerships between border security agencies and the private UAV sector to enhance border security. The participants mentioned government processes, corruption, and costs implications as potential challenges of implementing the envisaged partnerships. Five sub-themes emerged from this line of enquiry. The total frequency of responses provided by the participants in relation to the potential challenges of adopting partnerships between border security authorities and the private UAV industry were eight. **Table 6.19** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participants.

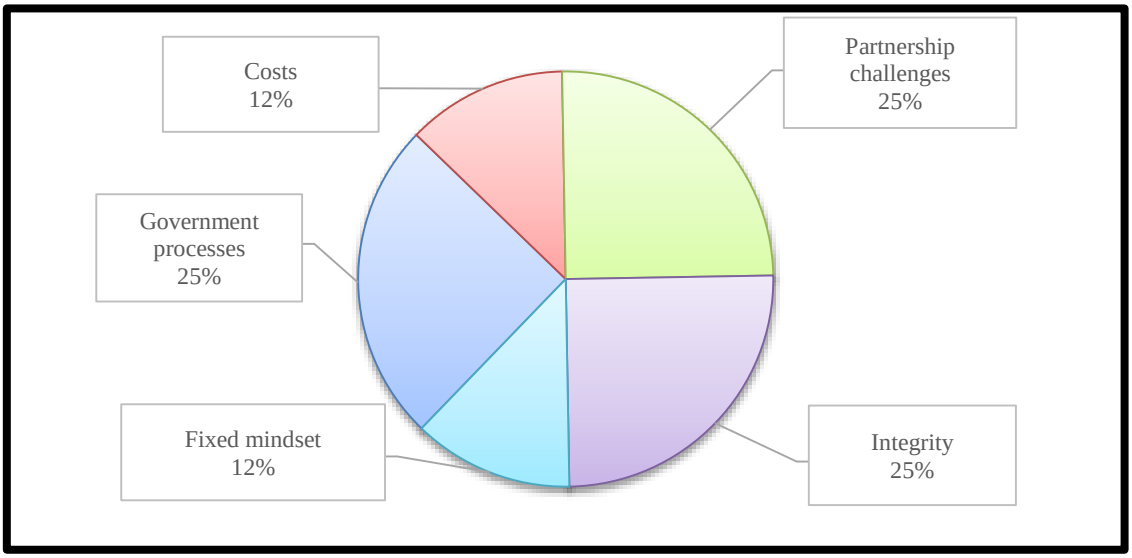
Table 6.19: Opinions of UAV specialists on the challenges of implementing PPPs for border security.

Potential challenges	**Frequency**	**Relative Frequency**
Fixed mindset	1	0.12
Integrity issues	2	0.25
Costs	1	0.12
Partnership issues	2	0.25
Government processes	2	0.25
Total	**8**	**1.00**

As indicated in **Figure 6.26**, some participants identified government policies and processes (25%); while others identified the formulation of effective partnerships as another potential challenge (25%). The participants further mentioned integrity issues, such as discrimination and corruption (25%). Other factors mentioned by the

participants were a fixed mindset and cost implications, with a relative frequency of 12% each.

Figure 6.26: Opinions of UAV specialists on the challenges of implementing PPP for border security.



Against the potential challenges of fostering effective partnerships for the enhancement of border security through space technology, Participant 8 indicated that the biggest obstacle would be funding:

> "Then to find reliable resources, especially human resources, and then to get facilities in place. There are also many private sector places that I have seen get contracts, but just don't deliver – the main reason is that there is usually funds allocated and contracts/agreements set up, but the funds are not made available on time".

Participant 3 mentioned lengthy government processes as a possible inhibitor. This related mainly to bidding processes and the appointment of suitable partners. The participant also said that to minimise possible challenges, the government would be better positioned to manage the appointed partners:

> "One of the biggest challenges I foresee and matter of fact it's been required, the processes of government most of the time are the biggest problem because how do you make sure that this government or in this instance you follow your processes but when you define or when you pick your partner, you know, you need to follow procurement processes but most of the time procurement processes they don't deliver or you don't necessarily end up with the best guy out there. We do all things that, you know, depending on how you structured your requirements, and did you tender; did you and how the next person responded to that need. So, you might actually end up with someone who might not necessarily be the best in the industry. That's one of the challenges with partnerships".

Participant 3 further indicated that:

> "…and one of the challenges that I also see and what would generally be in this instance the management part, you know, of the project must still be ensured from the government side; someone who's going to make sure that they properly and efficiently manage, you know, the appointed party because otherwise if they're not managed properly I mean you know sometimes some service providers they end up just, you know, lazing around and they don't care about deliveries and all that. So, it's quite important that that project is managed properly from the government point of view to make sure that what has been promised, what has been procured, is delivered".

In support of the above, Participant 7 commented as follows:

> "Unfortunately, due process and fixed mindset".

The various UAV technology experts interviewed concurred that UAVs could play a critical security role in the border security environment in South Africa. They further indicated that partnerships between border security agencies in South Africa and the UAV industry could be of value in the development and provisioning of the necessary

UAV technology for border security. On the other hand, the participants also highlighted some of the limitations in using UAVs for border security and the potential challenges that could be encountered when attempting to foster partnerships between the private UAV industry and the South African border security entities.

6.3.4 Satellite Technology Specialists

In this category of participants, the researcher interviewed only one participant. The participant was an earth observation specialist. The researcher focused on two main themes, comprising the extent to which satellites could be utilised for border security in South Africa; and the role the private satellite sector could play in the enhancement of border security in the country. Thus, the collection of data was aimed at addressing the following research questions:

- Research question 3: To what extent can space technology be applied to enhance land border security in South Africa?

- Research question 4: To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

6.3.4.1 Application of space technology (satellites) to enhance border security in South Africa

As an opening question, the researcher asked the participant to explain what a satellite is. In this regard, Participant 4 provided the following definition:

> "A satellite is anything that orbits around another thing. The moon is a satellite to the earth. The earth is a satellite to the sun. Okay, it is extended, it's not attached. I mean, it just means an extension, it's not joined, but the definition of a satellite is something that rotates".

Participant 4 further elaborated that:

> So, we put satellites up, and by definition all satellites will move around the earth… either they move this way, like your DSTV satellites. As the earth turns, they move with you, that's why your dish stays in the same direction, because that satellite, as the earth turns, it turns at the same speed. So, so a satellite for earth is something that is looking at the earth.

The researcher further requested the participant to describe the current utilisation of satellite technology across various settings. The participant mentioned several societal and civil applications of satellite technology consisting of communication, defence, military, and global positioning. **Table 6.20** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participant.

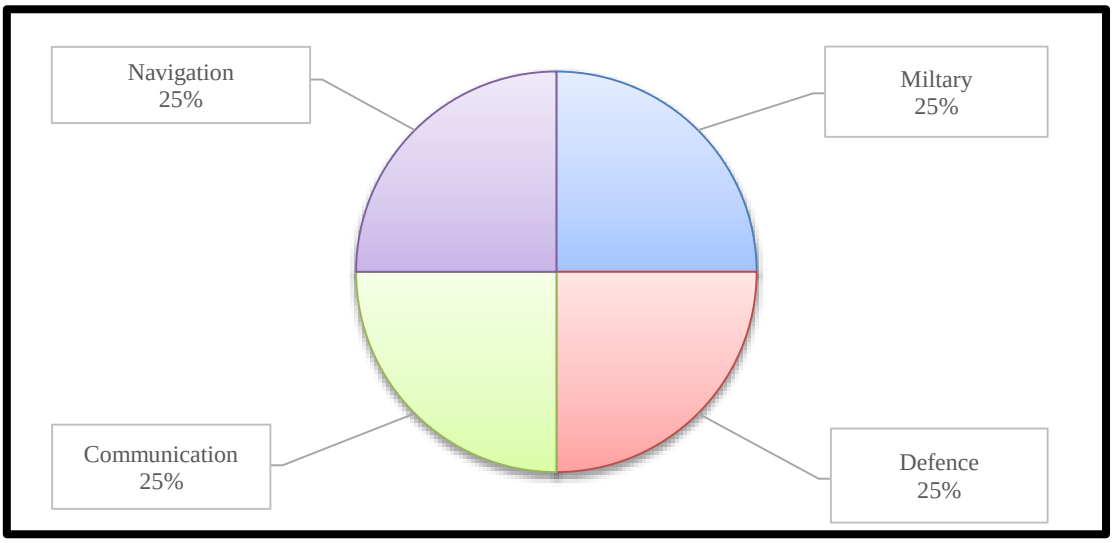
Table 6.20: Opinions of satellite expert on the application of satellites for border security

Application of satellites	Frequency	Relative Frequency
Communication	1	0.25
Defence	1	0.25
Military	1	0.25
GPS	1	0.25
Total	**4**	**1.00**

Figure 6.27 indicates that the participant in this research mentioned that satellites could generally be used in a variety of applications, including for defence (25%), military (25%), communication (25%), and navigation (25%) purposes. According to the participant, satellites can enable secure communication on earth.

The participant also made an example that satellites are able to provide digital television services such as in the case of pay television services. Moreover, the participant indicates that satellites enable secure communication within the banking industry such as in the use of Automatic Teller Machines (ATMs). Other applications of satellites as mentioned by the participant were in Global Positioning Systems (GPS).

Figure 6. 27: Opinions of satellites expert on the application of satellites for border security



On the various application of satellites, the participant indicated that satellites could be used for communication, global positioning, and navigation.

> "The satellite communication, so that is what a satellite does, it provides us on earth with services or data that we require for earth. Communication, which is entertainment. DSTV, secure communications, particularly in your world, defence, military. Government secure communication, banks, like I said the ATM, it's all under communication. Right, secure communication" (Participant 4).

Participant 4 further mentioned that:

> "So, it's communications, global navigation. GPS, for example, global navigation. Satellite system that can give your position, it gives aircraft their position in their height, their latitude and their altitude"

When asked about the extent to which satellite technology could be used for border security in South Africa, the participant partially agreed that satellites could be used for border security in the country. In this regard, Participant 4 stated:

"So, I do like to think that it would be possible".

However, the participant was concerned about a number of factors related to the deployment of satellites for border security in South Africa. Some of the concerns related to the practicality of utilising satellite technology, the accuracy of the technology, and the huge costs of such technology.

Two subthemes emerged in this process. Moreover, the sum of the frequency of responses provided by the participant in relation to the various applications of satellite technology were seven. **Table 6.21** provides the frequency of each subtheme and its frequency relative to other subthemes mentioned by the participant.

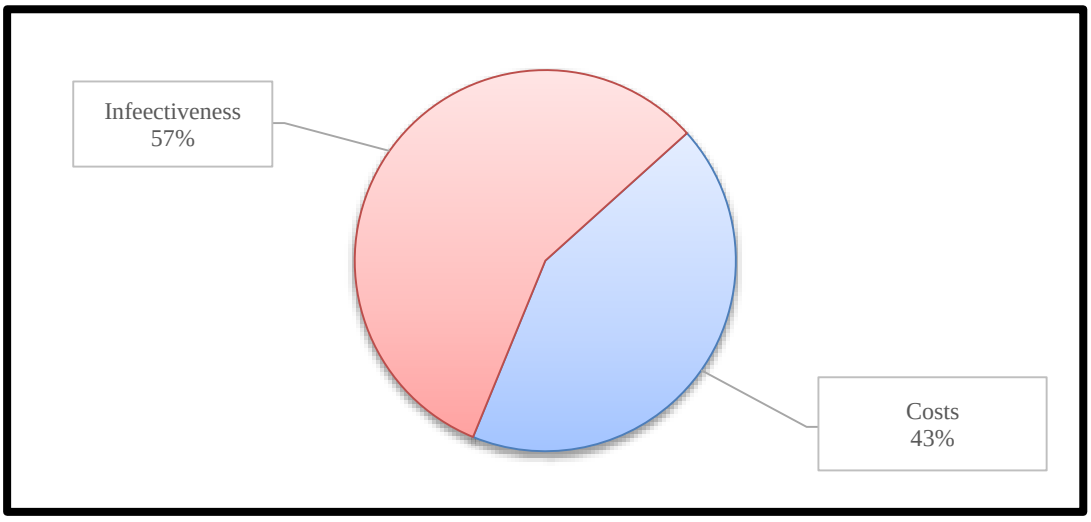
Table 6.21: Opinions of satellites expert on the challenges of using satellites for border security.

Possible challenges	Frequency	Relative Frequency
Costs	3	0.43
Ineffectiveness	4	0.57
Total	**7**	**1.00**

The participant was not completely in favour of utilising satellites for border security in South Africa. The participant said that deploying such as technology for border security in South Africa would not be easy. The participant also mentioned a few but critical challenges that might be associated with the use of satellites for border security, particularly so, for land border security.

The participant, as presented in **Figure 6.28**, stated that the deployment of satellites for border security would come at a huge cost (43%). The participant further reiterated that satellite technology would not be effective for land border security (57%), considering that it would be deployed to detect tiny objects such as humans and vehicles from a high altitude.

Figure 6.28: Opinions of satellites expert on the challenges of employing satellite technology.



Regarding the challenges of employing satellite technology, Participant 4 said the following:

> "The technology is not cheap and small enough at the moment, but quite frankly, you know you're looking at such a very small fine line, that you are taking a satellite, a bit of an overkill".

On the cost factor, Participant 4 stated:

> "The one thing is that satellites are very expensive, and it goes around like every 90 minutes. So, that is a very expensive exercise, because you need a number of satellites, you're going to need at least you know, nine, twelve satellites. Okay, you could do them cheaply, but it is definitely going to cost, it's going to cost a couple of hundred million, which is very cheap".

Apart from the cost factor, the participant also highlighted some practical challenges relating to the utilisation of satellites for border security in South Africa. One of the practical challenges mentioned by the participant raised concerns regarding the effectiveness of satellite technology for border security. In this instance, Participant 4 opined the following:

> "Right, so what we could do is, yes, satellites can help certainly, at the off chance that you might catch on actually on the satellite image, you might catch a person or two or a vehicle or two crossing the border illegally, is sure highly unlikely. What you could think about is, if you build a suite of satellites, for a different purpose, I mean you just want to see the border, but it goes around the whole world and comes back, you could image anything you really want. Then, right, you could help with other countries border security, we don't want that because you don't share that kind of information and understand National Security issues for every country".

Another practical consideration mentioned by the participant was the need to deploy a significant number of satellites. Given this, Participant 4 said:

> "You know, it's a thin line, you know. You are going to need a very high resolution. Very big camera; now if you're going to get nine very big cameras you are talking about a multi-billion rand problem. So, but if the earth turns, so I will see this part, let's say from the Kruger Park down to Joburg and the next 90 minutes I'll see Cape Town and I won't see the stuff in between. I may only see that stuff in between next week, you understand?"

In addition, the participant indicated that the speed with which satellites move between points would render their application less effective for border security in South Africa. Considering this, Participant 4 said:

> "…and it's moving pretty fast, you know you are talking about 11, 12 000 kilometres an hour, it's moving pretty fast. Goes around the whole world in 90 minutes and comes back. 90 Minutes, comes back, pretty fast right. So, you need a high resolution, because you don't want to see the paths, the footpaths, you actually want to see the human being".

The participant further stated that satellites would be able to assist border security authorities to identify tracks in the border area, which would indicate activities in the area. However, the participant said that the use of satellites had certain disadvantages. Apart from the huge costs associated with the deployment of satellite technology for border security, the participant stated that it could be difficult to differentiate between human and animal tracks. In this instance, the participant suggested that satellite technology that could assist with differentiating between human and animal tracks could be developed for that purpose:

> "For example, you will find the pathway between bushes, you know we don't know if they be from, from a satellite we would need to understand is it a a man-made pathway or an animal-made pathway. Of course, an elephant's path is different to a man. But now we won't have a high level of accuracy because it could be a kudu, which is kind of the same width and you understand and we, one of the, there are two challenges of, there are a few challenges actually with this, using a satellite… You know, so we need to have, we can see, we can take the image and then we will have an algorithm that will separate all the different things that make and see now if it's a man".

The participant recommended the use of UAVs instead, as they would be more cost effective than satellites. He also suggested cameras, but had some reservations about their deployment on the borders:

> "I mean, one solution for, for border security would really for me be with the UAVs… having UAV's roaming around that thing. That, would be able, I know there are some cameras that can, that can see the strokes on a kudu at night. From you know 100 metres away, kind of whatever altitude they're flying at. They that would certainly be a much more effective, which is, where you have cameras obviously. But to put cameras all along the border is now another problem. Because cameras fail and must be maintained. You must put a solar panel there, 'cause you've got no electricity cables. You need to have antennas so that it can send the video stream, I mean that's just a

> matter of protections… and it's probably one of the only best ways to do it, but then again, I can take a gun and shoot the camera out. Kilometres into the Kgalagadi… you aren't going to be able to catch me… I mean I'm right there; I shot the camera out, I cross over. By the time you get me, I'm 200 kilometres inside the country. You don't know where I am. You know, so having cameras there is not, you need to have cameras that are not visible, that cannot be damaged, like a UAV. Very high up with a satellite, and the person is not aware that they are being watched. That's what you want. Particularly, right…" (Participant 4).

Participant 4 stated the following in support of UAVs, as opposed to satellites:

> "You know, I mean, imagine if you take a picture of something that is 700 kilometres away. I mean, forgive me, I'm not too sure, I haven't seen the whole border, but sometimes it's just a fence. Hey, I mean and now you want, it's a little bit hard to see, especially from directly on top. You know, it's a thin line you know. You are going to need a very high resolution, I mean, one solution for border security would really for me be integrated with the UAVs".

From the discussion above, it can be stated that the sole participant was not in favour of the utilisation of satellites for land border security in South Africa. The two main concerns of the participant were the practicality and the costs of deploying such technology. The critical point mentioned by the participants was that it would require border security agencies to undertake a thorough cost-to-benefit analysis before they could decide to use satellite technology for border security in South Africa.

6.3.4.2 Public-private partnerships for enhancing border security in South Africa through space technology

Participant 4 had reservations about adopting PPPs for the enhancement of border security through satellite technology. The participant asked why a private partner would be interested in solving government problems. He also highlighted that it could

be that the government does not have the necessary technology; hence, it requires the assistance of the private sector:

> "Is it the best? Why are we proposing Public-Private-Partnerships? Because government has a problem doing it on its own. It's resources you know, so you, you bring in the Private Sector to partner with government to assist. That's really why we do. Either government doesn't have the technology, the know-how, the experience or it is a resource problem, we just can't employ 300 000 people to go stand two meters apart at the border post".

Moreover, Participant 4 stated:

> "I know there's… we have problems with illegal immigrants, what, what, but I won't be able to see that border being kept safe, or the efforts of the border being safe. In any part of my experience in my daily being, in my daily work. So, who is the customer? The country? Right, why would a private company come on board, well you need a PPP. You need a committed partner, but also then all the funding that is dependent on the government's ability to budget for the allocation for the security".

The participant also mentioned that should there be any form of partnership, funding challenges would hamper such efforts. In this regard, Participant 4 said the following:

> "Why would a private company come on board, well you need a PPP. You need a committed partner, but also then all the funding that is dependent of the government's ability to budget for the allocation for the security".

Participant 4 also expressed data security concerns regarding involving a private partner on matters of border security:

> "Well, for this type of thing, I mean this is, you know, very high-level security. Information, it's not top-secret but it's very high-level, you don't want this in just anybody's hands".

The sole participant in this category of participants in this research provided valuable insights into the possibility and the challenges of deploying satellites technology for enhancing border security in South Africa. The participant also commented on the possibility and challenges of implementing partnerships between border security authorities and private satellite companies. for the enhancement of border security in South Africa. The next section will discuss the key observations based on the discussions contained in Section 6.2 to Section 6.3 of this research.

6.4 Key observations relating to the data analysis process

In this study, the researcher made use of two data collection methods – documentary analysis and semi-structured interviews. The researcher analysed 36 documentary sources and interviewed 14 participants, comprising of four different categories of participants. The participants who were interviewed were border security officials; border security experts; UAV experts; and satellite technology experts. The interview schedule was designed to cater for each category of participants. Therefore, the questions contained in the interview schedule were not similar. However, border security officials and border security experts were asked similar questions. The only variation in the questioning was that UAV and satellite experts were not required to give their opinions on two research questions, namely the current threats and risks to border security in South Africa, and the challenges of border security in South Africa. See **Annexure F** for ease of reference.

Considering the above, this section of the research seeks to draw comparisons between the opinions of the participants, including the documentary sources on a particular theme or line of questioning based on the discussions in Section 6.2 and Section 6.3 of this study. Consequently, the researcher made the following key observations in relation to the data analysis process:

1) There were similarities in the opinions of the border security officials, the documentary sources, and the border security experts on the threats and risks to border security in South Africa. All the participants mentioned cross-border criminal activities, such as illegal border jumping, human smuggling, and the smugglings of illicit goods (comprising drugs, cigarettes, small arms and other goods), as the most prevalent threats and risks to border security in South Africa. Furthermore, the opinions provided by all the participants concurred with the subthemes, which emerged during the documentary analysis process.

2) All the participants and documentary sources collectively acknowledged that there were challenges in the provision of effective border security in South Africa. The opinions of the border security officials in this regard were supported by the views of the border security experts. Moreover, the documentary analysis process re-emphasised that border security authorities, the SANDF in particular, experienced significant challenges in the execution of their border security mandate.

3) The nature of the challenges of border security in South Africa, as mentioned by all the participants, was mainly attributed to the inadequate capacity of border security authorities to provide effective border security. This has been caused mainly by a lack of funding and the shortage of human resources. In terms of funding and human resources challenges, all the participants including the contents of the documentary sources concurred that there should be the provision of adequate funding, and sufficient resources should be made available to enable border security agencies to execute their mandates effectively.

4) Another major challenge, which was mentioned by all the participants, which affect the ability of border security entities to provide effective border security, was the border terrain, which made it extremely difficult to conduct effective foot and vehicle patrols. Against this background, the participants were of the view that the provision of suitable vehicles and the deployment of hi-tech assets, such as drones, sensors and radars, would be of greater value in

addressing the challenges encountered by border security authorities in controlling and monitoring South Africa's borders.

5) The researcher also observed an overwhelming concurrence that space technology, particularly UAVs, could be employed by border security authorities to enhance border security in South Africa. All the participants acknowledged the value that advanced technologies, such as UAVs and satellites, could add to border security in South Africa. The participants also suggested the integration of an array of socio-technological aspects of border security, such as radars, sensors, cameras and reaction teams, to enhance border security in South Africa.

6) Although all the participants concurred that various space technologies could be of value in enhancing border security in South Africa, the participants were concerned about the cost implication of such hi-tech assets, especially on the deployment of satellites for border security purposes. Most of the participants were also concerned about regulatory issues relating the use of UAVs for border security in South Africa.

7) Almost all the participants acknowledged the private space technology sector as a leader in technology innovation and development. The participants also acknowledged that the private space technology sector could be of great value in developing suitable technology for border security authorities through effective partnerships, which could result in several benefits for each of the partners in the partnerships. Such benefits could include efficiency and effectiveness in designing and providing suitable border security assets for the South African border security authorities. Other benefits mentioned by the participants were said to be enhanced border security, and cost and income benefits for each partner in the partnership.

Taking into account these observations, it can be stated that there are challenges related to border security in South Africa, which is caused by an array of factors. Regrettably, these challenges enable cross-border criminalities, such as illegal migration, the smuggling of stolen vehicles, human trafficking and the smuggling of illicit cigarettes,

drugs, firearms and explosives, to be perpetuated by transnational criminal organisations with relative ease. Therefore, the application of space-based technology for border security in South Africa through effective partnerships become imperative, as suggested by almost all the research participants.

6.5 Chapter summary

The findings of this study demonstrated that the South African border security environment experienced a number of threats and risks, including illegal migration, smuggling of goods, smuggling of stolen vehicles, smuggling of small arms, and stock theft. The findings also indicated that there were significant challenges related to the control and monitoring of South African borders. These challenges were recorded as a lack of funding of border security functions, inadequate resources for border protection and safeguarding, the borderline terrain and typology that made it difficult for border authorities to conduct effective patrols, and the lack of effective technology for border security.

The findings of the research further demonstrated that the use of space technology, such as UAVs and satellites, could be of value in enhancing border security in South Africa. The findings also revealed that the use of UAVs for border security could be much more effective than the use of satellites. Moreover, the findings demonstrated that effective partnerships between border security authorities and the private space technology sector could be of value in enhancing border security in South Africa through the application of space technology. The findings additionally revealed that although partnerships could be of value in enhancing border security in South Africa, there could be challenges that would hamper the effectiveness of such partnerships.

CHAPTER 7

INTERPRETATION OF THE RESEARCH FINDINGS

7.1 Introduction

In the previous chapter, the researcher analysed the data obtained from documentary sources and semi-structured interviews. The various collective understandings held by the participants on the threats and risks to border security; the challenges of border security; the extent to which space technology could be employed to enhance border security, and the possibility of forming PPPs between border security authorities and the private space technology industry emerged during the data analysis processes. As such, it becomes imperative to test the relevance of the collective understandings of the research participants against the reviewed literature and international best practices on the various socio-technological aspects of border security.

This chapter aims to equate the collective viewpoints held by all the participants with the relevant theoretical outlines, as presented by the researcher in Chapters 2, 3 and 4 of this study. The researcher will point out similarities, differences and significant relationships between the viewpoints of the participants and available literature in line with the research questions presented in Chapter 1. The researcher will also provide a synopsis of the data analysis process, as presented in Chapter 6, followed by a summative discussion of the findings thereof.

The findings of this research will then be synthesised with the relevant literature, after which significant similarities and differences will be explored within the context of border security, space technology, and PPPs. Therefore, the interpretation of the research findings will be aligned to the research questions, and will follow the following sequence:

1) Threats and risks to border security in South Africa.

2) Challenges of border security in South Africa.

3) Application of space technology to enhance land border security in South Africa.

4) Public-private partnerships for enhancing border security in South Africa through space technology.

7.2 Threats and risks to border security in South Africa

In this section of the research, the researcher sought to comprehend the various threats and risks to border security in South Africa from the expressed views of the South African border security authorities supported by experts in the field of border security. Considering this, the review of available literature, as presented in Chapter 2 of this study, exposed an array of threats and risks to border security faced by South Africa. The participants in this study have mentioned transnational criminal activities such as border jumping, human smuggling and trafficking, stock theft, and the smuggling of goods, illicit cigarettes, dagga and stolen vehicles as the most prevalent threats and risks to border security in South Africa. The participants also mentioned instances of the smuggling of small arms and explosives, illegal grazing, and possibilities of terrorist acts as some of the threats and risks to border security in South Africa. The analysis of the viewpoints of the research participants suggested that the threats and risks of illegal migration, for instance, were most prevalent in the South Africa-Zimbabwe and South Africa-Mozambique border areas, with instances of stock theft and illegal grazing being most prevalent in the South Africa-Lesotho borders.

The results of the examination of the threats and risks to border security in South Africa through the documentary analysis and semi-structured interviews are similar to what was established by the researcher during the literature review process. Authors such as Mahlangu (2016), Martin (2018) and Mahlangu and Obioha (2015) state that transnational criminal activities such as human smuggling and trafficking, stock and vehicle theft, terrorism, and the smuggling of goods, arms and narcotics are some of the border security threats and risks faced by South Africa.

In support of the views of the participants that cross-border livestock theft and smuggling is more prevalent on the South Africa-Lesotho borders, Martin (2011), Pule (2013) and Maluleke and Dlamini (2019), as discussed in Section 2.7 of this study, also revealed that stock theft is rife in areas such as the Eastern Cape, KwaZulu-Natal and the Free State. This could be because some parts of the Eastern Cape, KwaZulu-Natal and the Free State border Lesotho, and livestock is often stolen and transported to and from either side of the borders.

There is also a correlation between the findings of the research and the review of literature that South Africa experiences cross-border poaching and the trafficking of wildlife. According to Adams and McShane (1992), Gyimah (2006), Maguire and Haenlein (2015), ISS (2017) and Baruti (2018), South Africa is regarded as one of the most vulnerable countries when it comes to wildlife-related crimes. These authors mention that cross-border poaching activities are executed mainly by criminal syndicates. These syndicates are also involved in other criminal activities, including diamond and drug smuggling, cattle rustling, and human trafficking. The positioning of the KNP and other trans-frontier conservation areas, which are located on the borders between South Africa and Botswana, Namibia, Mozambique and Zimbabwe, exacerbate the problem of wildlife poaching and smuggling in South Africa.

The review of literature also indicated that hijacked and stolen vehicles are often smuggled across the South African borders to neighbouring countries, such as Mozambique, eSwatini and Zimbabwe. The responses of the participants and the results of the documentary analysis concurred with available literature, as discussed in Section 2.7.1 of this study, that the smuggling of stolen vehicles is one of the many border security threats and risks faced by South Africa (BBC, 2017; TimesLIVE, 2017; Maluleke & Dlamini, 2019). Similarly, the participants and the literature review indicated that explosives, which are mainly used in various criminal activities such as illegal mining and ATM bombings, are smuggled into South Africa through the porous borders. Other smuggling activities mentioned by the participants in this research and mentioned by various authors in the reviewed literature comprise the smuggling of firearms, drugs, and illicit cigarettes (Geldenhuys, 2019; Bopape, 2014; Mothibi, Roelofse & Maluleke, 2015; Pienaar, 2015).

Illegal border crossings are said to be a daily occurrence in many parts of South Africa's borders. These threats and risks were widely mentioned by the participants in this research and contained in most documentary sources analysed by the researcher. Illegal border crossings occur in various forms, including border jumping, human smuggling, and human trafficking (Kanko et al., 2013; Marchand et al., 2016; Molemma, 2013). Although the available literature suggests that incidents of illegal or clandestine migration could have implications for national security, public safety, and public health safety, as mentioned by Koser (2005) and Rudolf (2003), there is an absence of expressed indication from the participants that this was the case in the South African context, apart from one participant who mentioned terrorist activities as a possible threat to border security in South Africa. On the issue of public health safety, it could be argued that the reaction of the South African government of speeding up erecting a border fence near the Beitbridge border post between South Africa and Zimbabwe in March 2020, to curb the spread of the COVID-19 virus by preventing illegal migration through undesignated points of entry could be an acknowledgement that illegal migration could create challenges related to public health safety in South Africa.

Given the above discussion, it could be concluded that there was a correlation between the expressed views of the participants interviewed by the researcher, the documents analysed by the researcher, and the literature reviewed by the researcher on the most prevalent threats and risk to border security in South Africa. It could also be concluded that South Africa experienced an array of cross-border criminal activities.

7.3 Challenges of border security in South Africa

This line of questioning sought to determine the challenges of providing effective border security in South Africa. Therefore, this theme dealt with the practical challenges faced by border security officials in executing their border security mandate; the views of senior border security officials on the challenges experienced by border security authorities; and the views of border security experts on what could be the challenges of border security in South Africa.

South Africa experiences significant challenges in monitoring and controlling its international land borders. The analysis of documents and the interview transcripts of the semi-structured interviews highlighted several borders security challenges experienced by South Africa's border security authorities. Given this, the review of literature, as presented in Section 2.6, suggested that managing South Africa's international borders was a daunting task for border security authorities and it was not a new phenomenon. The challenge of managing South Africa's border was caused by an array of factors, including the length of the South African borders, which stretched over a distance of over 4700 kilometres; an unfavourable border terrain, which made it difficult to patrol the borderline; physical resources and human resources deficits experienced by border security authorities; ineffective border security strategies; and the absence of physical barriers separating South Africa and its neighbouring countries. Other challenges of border security in South Africa identified in this research were said to be corruption among border security officials, and legislative and institutional discrepancies, which caused fragmentation in the entire border security function.

As per the review of literature, as discussed in Section 2.6.5, Nsereko (1997) and Wiese (2019) indicated that the land border terrain in most parts of the border area in South Africa was long and open; densely populated; mountainous and bushy; and was difficult for border authorities to monitor and control. For example, in most parts of the border areas of South African and Botswana, the border fence was often a short agricultural barrier with no deterrence value. Moreover, the roads along the borderline were generally inaccessible making it extremely difficult, if not impossible, for authorities to conduct the necessary monitoring (such as foot and vehicle patrols). These views were echoed by the research participants and were contained in various documentary sources examined by the researcher, as presented in Chapter six of this study. The participants indicated that the border areas, such as the area between South Africa and Mozambique, South Africa and Zimbabwe, and South Africa and Lesotho, were mountainous, making it difficult to patrol the border area. In view of this, some of the participants suggested that border security authorities should be equipped with four-wheel drive vehicles to enable them to conduct effective border patrols.

The participants also commented on the absence of a borderline fence in most of the border areas in South Africa. They indicated that the absence of a border fence made it easier for illegal migration and other cross-border criminal activities to occur. Similar views are contained in Section 2.6.5 of this study, where Mahlangu and Obioha (2015), Mahlangu (2016), Magubane (2018), Simelane (2016), Wiese (2019) and Macheka *et al* (2015) stated that the absence of a border fence fuelled illegal migration and other cross-border criminal activities. They indicated that these challenges were more prevalent on the South Africa-Lesotho borders, the South Africa-Zimbabwe borders and the South Africa-Mozambique borders. These authors also indicated that on the South Africa and Lesotho borders illegal migration and other cross-border criminal activities were executed by merely crossing the river and walking through the bushy area along the border and ultimately reaching the border fence where the cross into South Africa through the non-existent border fence.

Inadequate funding for border security operations was confirmed by the research participants and the documentary sources as one of the border security management challenges. Senior members of the SANDF and the Minister of Defence have voiced concerns on the issue of the underfunding of the SANDF, which severely affects the SANDF's ability to execute its mandate, including the border security mandate. Border security experts interviewed in this research also commented on the issue of underfunding as another factor that hampered the ability of the SANDF to safeguard South Africa's borders. Although the participants mentioned the lack of resources as a separate challenge experienced by border security authorities, this aspect could be linked to underfunding, which made it difficult for the SANDF to acquire the necessary border security assets and to deploy adequate human resources for border security missions. The Minister of Defence and other senior SANDF officials indicated that the SANDF had 15 companies deployed for border safeguarding, which was inadequate for the task, as it required over 20 companies.

Although the reviewed literature highlighted that corruption among border security officials was a challenge of border security, only a few participants in this research opined that this was the case in the South African context. Corruption is often associated with the trafficking and smuggling of illegal migrants. Criminal organisations responsible for the trafficking and smuggling of illegal migrants often

pay money to public officials as a way of undermining and neutralising the entire system of law enforcement designed to fight illegal migration and human trafficking (Agbu, 2003; Borjas & Crisp, 2005; Spencer et al., 2006).

A study by Mabudusha (2014) found that the experiences of undocumented migrants, who crossed through the Beitbridge, Limpopo and Ficksburg border posts in South Africa, were good. The study also found that many undocumented migrants were known to the police and were often unduly allowed to cross the border back and forth without any hindrance. The author (2014) further noted that whilst the police were overwhelmed by the number of undocumented migrants at the identified border posts, they were more sympathetic to undocumented migrants than police officials in areas far from border posts, such as Johannesburg. There have also been media reports, as presented in Section 2.6.7, which stated that it was easier to cross into and out of South Africa using bribery and corruption.

On the issue of the porousness of South Africa's borders, authors such as Tati (2008) and Dithebe and Mukhuba (2018), as contained in Section 2.6.5, commented that South African borders with its neighbours are extremely porous and have often been blamed for the problem of illegal migration. They also suggested that border jumping was the preferred option for many migrants wishing to enter South Africa because the country discouraged migration legislation. The participants agreed that South African borders were porous. The porousness of the borders could be attributed to several factors. Considering the earlier discussion, the porousness of South Africa's borders could be attributed to factors such as inadequate capacity to monitor and control the South African borderline; the lack of a border fence to curb cross-border criminal activities; the length of the entire South African borderline, which made it difficult to control in its entirety; and an ineffective border safeguarding strategy.

The two categories of participants, border security officials and border security experts, further stated that the lack of a proper border security strategy contributed to the challenges of border security faced by South Africa. The review of literature, as discussed in Section 2.6.1, traces the issue of the lack of an effective border security strategy back to the attainment of democracy in 1994. Since the attainment of democracy, South Africa has been struggling to adopt proper border management

structures and processes. This has been observed through problems of cooperation among border security authorities. Moreover, since the advent of democracy, the borderline security function has been passed back and forth between the SANDF and SAPS.

The review of literature also found that despite the formation of various border management and control structures, such as the lead agency model, and inter-departmental coordination, problems of a disjointed border security management function continued to exist (Steinberg, 2005). Similarly, Minnaar (2001) found that the issue of the full integration of all border security processes was lacking in the South African context. In their research, Mahlangu and Obioha (2015) and Mahlangu (2016) also established that there was a lack of effective coordination and cooperation, which led to the ineffectiveness of the current multi-agency approach to border control in South Africa.

Considering the issue of the border security strategy, the Minister of Defence also indicated that securing South Africa's territorial integrity had become more of a challenge as it shaped its national security strategy and geared towards implementing the BMA. The BMA would encompass all the role players within the security cluster and beyond, state and non-state actors included (DefenceWeb, 2009). The Secretary of Defence, Dr Sam Gulube, as highlighted in Section 6.2 of this study, also stated that the DOD was considering new methods of fulfilling its border-safeguarding mandate in consideration of declining departmental budgets and inadequate resources. Therefore, the DOD had developed a draft Border Safeguarding Strategy to secure the air, land and maritime borders (DefenceWeb, 2018a).

Frowd (2015) and Duggan and Hinman-Sweeney (2009), as discussed in Section 2.3 of this study, stated that the provision of effective border security and control was dependent on a range of factors, which are commonly known as the socio-technical aspects of border security. These socio-technical systems comprise both human and non-human elements interacting with each other in the provisioning of effective border security in any country. The provision of effective border security is mainly dependent on the effective management and control of these two factors and superior interaction between these factors. Moreover, one factor is no more important than the other is, but

these factors seek to complement each other in order to provide effective border security and control. Thus, the incapacity of the border security authorities, and mainly the SANDF, to acquire the necessary human and non-human assets hampers its efforts to provide effective border security in South Africa.

The DHA (2017) has concurred that departments tasked with ensuring border security in South Africa lack the necessary capacity to deal with the mammoth task of securing the country's borders and to effectively deal with the threats and risks to border security. According to the DHA, capacity refers to all key factors that are necessary to allow a state to manage issues of international migration and the borders. These could include a clear vision, a legal, policy and institutional framework, and the resources and system required to implement those policies and laws. Thus, the lack of capacity to secure South Africa's borders could be attributed to a lack of appreciation of the strategic importance and the positive role managing international migration has in economic development and enhancing national security.

7.4 Application of space technology to enhance border security in South Africa.

The preceding section highlighted the challenges experienced by border security authorities in South Africa in executing their border security mandate. Apart from the aspect related to governance structures, processes and procedures, which can be mainly referred to as the policy position and border security strategy, other challenges experienced by border security authorities relate to the technical aspects of border security, such as the inability to cover a wider area of the border on foot and vehicle patrols; terrain that is not easily accessible for effective border safeguarding; and the lack of proper technology to aid border security officials in their daily duties.

The challenges of controlling and monitoring South Africa's borders require the adjustment of the country's border safeguarding tactics in line with international best practices to enhance the detection, interception and prevention of an array of cross-border criminal activities, such as drug and narcotics smuggling; wildlife crimes; illegal migration; human trafficking; and vehicle theft and smuggling. The notions of boots on the ground and senseless conventional border patrols have proven to be

ineffective border security activities in the South African context. As such, technologies such as UAVs and satellites, as discussed in detail in Chapter 3 and Chapter 6 of this study, have been identified as technological solutions available to South Africa to strengthen it border security mandate.

7.4.1. Unmanned Aerial Vehicles

As suggested by the participants in this study, there is a need to employ space technologies such as UAVs and satellites to control and monitor South African borders. The participants also indicated that other hi-tech assets such as sensors, radars and cameras could be integrated with UAVs and satellites to enhance the effectiveness of border security measures in South Africa. The review of literature further revealed that many countries find it difficult to detect and intercept intruders and criminal elements who attempt to cross their international borders.

One of the main challenges faced by border security authorities globally in controlling and monitoring long stretches of a country's borders is the need for intensive human involvement. This is also the case in the South African context. In consideration of this challenge, countries such as India, Switzerland, Egypt and the USA have sought alternative measures such as the employment of space-based technologies to control and monitor their international borders (Pedrozo, 2017; Volkan, 2014; Kumar, 2019; Alkhathami et al., 2015; *The Economic Times*, 2019; Wilson, 2018). The literature also indicates out that several technologies, such as video surveillance equipment, radars and satellites, are employed by border security entities to control and monitor national territories. UAVs, which were supported by all the participants in this research, also form part of these border security technologies and have been recognised as key surveillance and identification systems being implemented globally (Klauser & Pedrozo, 2015). Other technologies, which were recognised by the participants in this research and equally supported by available literature as alternatives to conventional border security measures, are wireless sensors and ground-based electro-optical sensors that could be linked to satellites to monitor and control borders (Felemban, 2013; Szechtman et al., 2007).

The participants in this research fully supported the use of UAVs for border security in South Africa. They mentioned the potential benefits that might be derived from using UAVs for border security. The participants agreed that, if adopted, UAVs could benefit border security operations in South Africa. They could be used for missions, such as ISR. They could also be used for border patrols and for delivering supplies to border guards in remote border areas. The participants also said it would be much cheaper to deploy UAVs for border security, as opposed to satellites and intensive human resources. This implies that UAVs could minimise the challenges of inadequate human resources as they could serve as a force multiplier; they could also access border areas that are not easily accessible due to factors such as unfavourable border terrain and unmaintained border roads. Moreover, UAVs could patrol larger parts of the borderline, as opposed to foot and vehicle patrols. In this instance, one of the participants said that the mountainous border area made it difficult to reach or access long stretches of the borderline. Therefore, space technology could ensure that these areas were monitored remotely; thereby enhancing border security. The participants further indicated that border guards in South Africa operated in harsh and complex terrains, which could be dangerous for the border guards. Therefore, the deployment of UAVs could simplify the control and monitoring of South Africa's borders, while keeping its operators at a safe distance (Gadda & Patil, 2013; Liu et al., 2019).

Another border security challenge mentioned earlier was the issue of corruption. Considering this aspect, one of the participants said that technology was not prone to corruption. This implied that if UAVs were deployed to border areas for patrols, guards could stream live videos and images of the border situation to a central command centre to alert them of activities taking place on the border. This would also serve as a tool to monitor border guards posted in remote areas and serve as a deterrent; thus, ultimately minimising the prevalence of corruption at the borders.

The participants and various authors, as contained in the reviewed literature, concurred that UAVs could be used for a wide range of activities in the border security environment. It has been recorded that UAVs could be used for the transportation of supplies to border guards, intelligence gathering and reconnaissance, border surveillance, as well as the inspection of border fences. The advantages posed using UAVs are that they are automated, autonomous, and reliable (Shishkov et al., 2017;

Hartmann & Steup, 2013). Another advantage offered by UAVs over foot and vehicle patrols is their flexibility in providing their services at any given time. Similar sentiments were advanced by Wilson (2018), as discussed in Section 3.5 of this study, who indicated that UAVs could operate without an airfield; had greater endurance as opposed to manned aircrafts; were relatively difficult to be seen and avoided by smugglers; and were less expensive to operate. The author (2018) further stated that UAVs could reach remote areas quicker than patrol vehicles and border guards on foot; and could provide users with tactical space-based intelligence, surveillance and reconnaissance capabilities to enhance the effectiveness of patrols vehicles, boats and officials in the field. Available literature also suggested that UAVs could be operated by a single operator, which significantly reduced the number of personnel required to monitor the border (Marube et al., 2017; Wilson, 2018).

An analysis of international best practices revealed that countries such as the US made use of UAVs to monitor their borders, where larger parts of the US-Mexico border were monitored by UAVs alone. This move is aimed at controlling remote stretches of the US-Mexico border by UAVs only, where there will be no border guards, fences, ground sensors or camera towers. Thus, UAVs are used by the USA to clamp down on illegal migration, drug smuggling, and human trafficking activities (*The Guardian*, 2014; Payan, 2016; Sterman & Brauer, 2019). Additionally, Switzerland uses UAVs to control and monitor Switzerland's border areas (Ceyhan, 2006; Pedrozo, 2017). In the African context, Nigeria also uses drones for security surveillance, intelligence gathering, and anti-terrorism missions to discourage the illegal movement of persons and goods into the country (Ofikhenua, 2019; Abiodun, 2020).

The discussion above indicates that South Africa could benefit significantly from the use of UAVs for its border security missions. The use of UAVs could eliminate or minimise many of the challenges of border security, as highlighted in Chapter 6 of this study, such as the shortage of border guards; the lack of fences in large parts of the border area; the length of the South Africa border; as well as terrain which is difficult to access by foot or vehicles. Although the reviewed literature and the research participants concurred that UAVs could add value to border security in South Africa, notable challenges were mentioned by the participants and recognised in the reviewed literature. The participants mentioned potential challenges relating to the utilisation of

UAVs for border security in South Africa. Some challenges mentioned by the participants, as contained in Section 6.3.2.3 and 6.3.3.1 of this study, comprised regulatory issues; skills and training requirements for operators; and the costs associated with the procurement of such technology.

Other potential shortfalls mentioned by the participants included network and communication challenges in remote border areas; limited flying time; and the impact of adverse weather conditions. As discussed in Section 3.6 of this study, Hartmann and Steuo (2013) are in support of the research participants, highlighting those environmental factors could affect the communication links related to the operation of UAVs. This is more relevant in the border environment, where there is an absence of, or inadequate communication systems, for effective border security operations. Remote border areas, as in the case of the South African borders, often lack the necessary power and communication infrastructure to enable the application of various technological instruments. The impact of weather on the operations of UAVs was also mentioned by a few participants in this research as a potential inhibitor of using UAVs for border security.

Coeckelbergh (2013), as discussed in Section 3.6, asserted that some UAVs were sensitive to bad weather conditions, such as rain or heavy fog. These unfavourable weather conditions affect UAV surveillance operations and often lead to changes in the patrol route; thus, changing the pattern of surveillance and the targeted areas. In other instances, border security authorities abandoned drone engagements due to climatic factors. Considering this challenge, the researcher supports the views of the participants that UAVs should be used together with other socio-technical aspects of border security and should not aim to replace all of the border security assets.

As stated in the preceding paragraphs, the participants mentioned poor road conditions and rough terrain along the borderline as challenges of border security in South Africa. Against this background, Hartmann and Steuo (2013) indicated that poor road infrastructure in remote border areas might affect the deployment UAVs to those areas. According to the United Nations Economic and Social Council (2020), rough terrain and dense vegetation could negatively affect the quality of images produced by an

UAV's sensory equipment; thus, limiting its effectiveness in the border environment. This could cause failures in UAV control systems, resulting in accidents.

Other non-technical potential inhibitors of using UAVs for border security, as highlighted by Coeckelbergh (2013), include the integration of various role players in the border security environment, including pilots, operators, border guards and technical teams. Pedrozo (2017) stated that introducing UAVs for border security would necessitate the training of UAV pilots, which would bring about additional financial costs. Thus, the skills and training of these various actors was critical for the operational effectiveness of UAVs. The participants in this research shared the same views and indicated that the deployment of UAVs for border security would require the training of operators. A participant said, "Because ja, if you appoint people that are not technology orientated, then that becomes a problem. That is going to be inhibiting because we deploy that technology, people want you to solve to remain useless."

The cost of purchasing, operating, and maintaining UAVs was also widely mentioned by the participants as a potential inhibitor of deploying UAVs for border security in South Africa. Similar views were held by Bolkcom and Nunez-Neto (2008) and Bier and Feeney (2018) who indicated that there were cost implications relating to the procurement and operations of UAVs. They further indicated that the costs of operating UAVs could be higher than the costs of operating manned aircrafts. Moreover, an aspect mentioned by most participants as a potential major inhibitor of utilising UAVs for border security in South Africa was the regulations of the Civil Aviation Authority (CAA). As one participant said, "Current CAA regulations will inhibit full potential of UAV border patrol". Another participant stated, "Operations of drones are regulated. So, one of the challenges that you might have obviously may be in civilian rules or are you going to follow military rules".

Bolkcom and Nunez-Neto (2008) and Bier and Feeney (2018) indicated that the use of UAVs was subject to numerous legal requirements, such as licensing issues and other aspects of international relations, especially when operated near international borders. Moreover, UAVs may not be flown in areas where there is a high presence of commercial flights. Additionally, Milivojevic (2015), Bier and Feeney (2018), and Koslowski and Schulzke (2018) stated that UAVs, when operated in border areas,

could collect large amounts of information about residents along the borderline. This is also relevant in the South African context where private farms and private nature reserves are in border areas. This situation would call for the creation and maintenance of good diplomatic relations with neighbouring countries and good working relationships with border communities. Moreover, UAVs should be used solely for border surveillance operations and not for any privacy infringing activities.

There was disagreement between the views of the participants and those of some of the authors, as contained in Section 3.6 of this study. Some participants indicated that a benefit of UAVs is their ability to operate silently, as opposed to manned aircrafts. One participant said, "You know, and another challenge obviously with a helicopter is that operation cannot be covered. Now I mean even when you fly a helicopter, they will know there is a helicopter in the vicinity and run away and hide and all that. So, with a drone you wouldn't even know that someone is watching, you know; that's one of the advantages of using that drone, and you know, you've seen that kind of technology". In contrast, Hartmann and Steuo (2013) indicated that drones emitted loud noises, which limited their ability to move discretely into an open space; thus, allowing them to be seen and heard by the targets of surveillance.

Other concerns raised by the participants on the use of UAVs for border security were flight duration and distance. The participants stated that most UAVs have only limited flight time capacity, unless they were military-grade long endurance drones. However, as indicated in Section 3.5.2 of this study, South African companies such as Denel Dynamics, Milkor, ATE and CSIR all have the capability to develop military UAVs concepts, inclusive of hand-launched drones with ISR capabilities and larger armed UAVs. One examples is the Milkor MA380 drone, which is capable of undertaking long-endurance missions such as search and rescue activities, maritime patrols, and ISR missions. Milkor MA380 has a flight endurance of 20 hours and can travel some 2000 kilometres. It is also capable of sending real-time images and videos to ground control staff (Milkor, 2018; Husseini, 2019).

The review of literature and the viewpoints of the participants further revealed the potential benefits of utilising UAVs for border security. However, they also indicated potential shortfalls of using UAVs for border security. Against this background, the

researcher is of a view that there was conclusive agreement between the views of the participants and the available literature, as contained is Section 3.5 and Section 6.3 of this study, on the benefits of utilising UAVs for border security in South Africa.

Given the above, issues for further consideration on the deployment of UAVs for border security in South Africa comprise cost implications; regulatory and privacy issues; and the effectiveness of UAVs against the cost implications.

7.4.2. Satellites

Apart from the use of UAVs for border security, satellites are regarded as space technologies that could be used for border security in South Africa. Although they were less preferred by the participants in this study as an alternative to current measures of border security in South Africa, they were considered as valuable assets for border security, if South Africa was able to afford them. Given this, most of the participants were in consensus that satellites could be used for border security in South Africa, except for a few participants who were not in favour of utilising satellites for border security, citing factors such as cost and their ineffectiveness when utilised for land border security.

The participants further stated that satellites could serve as force multipliers in the border security environment; they could also be integrated with other technologies, such as radars, sensors and camera towers, to enhance border security in South Africa. Available literature, as discussed in Section 3.5.1, highlighted that satellites could be of value in border security as they were able to provide border security authorities with detailed images of high-risk areas where there was an increase in illegal border crossings. Satellites could further conduct wide area surveillance and were able to access remote areas. According to Malinowski (2010) and Berkowitz et al. (2019), satellites offered several benefits for border security, including visibility, through earth observation satellites. They further mentioned that in vast border areas, border guards might be stationed kilometres apart and would most likely be dependent on a variety of electronic surveillance technologies to detect and track intruders and suspicious activities.

Another benefit of using satellites for border security related to their ability to be used for multiple purposes. The participants indicated that space base technologies, such as satellites, could be used for weather observation, situational analysis, and environmental management. For example, one participant said, "If you've deployed those systems for weather, for situational analysis, if you're able to analyse what is happening in the border environment within the border line, the people crossing illegally, when these things are happening". These views were supported by authors who indicated that satellites could be used in a variety of activities, including for monitoring targeted border areas, disaster management, and search and rescue missions. They further mentioned that images from satellites help in detecting illegal trafficking paths along a country's international borders (Berkowitz et al., 2019; DefenceWeb, 2018b; Duggan & Hinman-Sweeney, 2009).

The participants mentioned several roles that satellites could fulfil, in addition to earth observation. One of the participants stated, "… also about communications, cell phone coverage. I also indicated to you what big problems we are experiencing at the borders with cell phone coverage continuously and that's why I think one of the biggest advantages of space technology lies in communication". This was supported by the literature, as presented in Sections 3.2.2.1 and 3.5.1, which revealed that apart from border surveillance, satellite technology could provide a multitude of communication platforms, such as calls, video communication, the streaming of various media formats, and satellite television and radio. Therefore, satellite technology offered unique and practical solutions that could help nations to overcome many communication challenges (Marshall, 2017; Greenblatt & Anzaldua, 2019). The Space and Satellites Professionals International (2016) further indicated that the border security environment required extensive sharing of information about a wider area of operation and to various and widely dispersed border security assets. Therefore, satellites were the most suitable border security assets to undertake this task.

Because only one satellite technology specialist was able to participate in this study, the input of the participant in relation to the benefits of using satellite technology for border security was limited. Moreover, the analysis of data indicated that the participants could not provide as much feedback as when commenting on the use of UAVs for border security. Despite this, the review of literature and the limited opinions

of the participants indicated the potential benefits of using satellites for border security, more especially if the technology was linked to other hi-tech assets, such as automated radar surveillance equipment installed at land borders to detect moving targets near the borders. Another potential benefit of satellites in the border security environment was said to be their ability to provide detailed images of hotspots in certain parts of the border area, prone to illegal border crossings. The review of literature further indicated that UAVs operate through satellite-based technologies and when utilised for border security, they shared vital border situation awareness with border security officials on the ground. Another use of satellite technology in the border security environment was for navigation purposes (Sivaramaganesh et al., 2004).

Without negating the potential benefits of using satellites for border security in South Africa, the participants provided the potential downsides of utilising satellite technology for border security. In the main, they mentioned the huge cost implications. Some participants also stated that satellites would be less effective in the land border security environment, considering the size of targets they would be deployed to detect and observe (such as humans and vehicles). In this instance, the satellite technology specialist indicated that this endeavour would require expensive high-resolution cameras. For example, one of the participants said, "I mean that's ideal, you want to see the human being right, but to see a human being you are going to need a high resolution, which means a very big camera. Very big camera, now if you're going to get nine very big cameras, you are talking about a multi-billion-rand problem".

On the issue of costs, the Organization for Economic Cooperation and Development (OECD) (2019) holds similar views, indicating that most often developing countries do not possess the capability and expertise to produce satellite technologies. This situation serves as a barrier for those countries to expand the use of satellite technologies, including for border monitoring. Contrary to what the participants mentioned as a potential impediment to deploying satellites for border security in the South African context, the literature suggested otherwise. According to Defenceweb (2018), the cost of developing and launching satellites dropped significantly in recent years, especially with small satellites like CubeSats and nanosats. Therefore, developing countries such as South Africa could take advantage of this development and use satellites for a variety of ground-based activities, including border monitoring.

Despite the issue of costs associated with the deployment of satellites for border security, almost all the participants acknowledged that satellites, when integrated with other technologies such as radars and sensors, could be of value to border security in South Africa. The discussion above also revealed that a proper combination of socio-technical aspects of border security, such as the deployment of space-based technology, might be beneficial to South Africa's efforts of enhancing border security. This also becomes critical when South Africa is in the process of streamlining governance structures and processes through the establishment of a single entity, the BMA, which would be responsible for all the aspects of border security in South Africa. Although the single agency approach might be beneficial in addressing governance-related issues and challenges in the South African context, as identified earlier in this research, it might not necessarily fix the issues and challenges related to the technical aspects of border control and monitoring in South Africa. Thus, the deployment of suitable space technology, integrated with other socio-technical aspects of border security, could be the ultimate solution to border security challenges in South Africa.

7.5 Public-private partnerships for enhancing border security in South Africa through space technology

In this section of the research, the researcher sought to explore the views of the participants on the possibility of implementing partnerships between the private space technology industry and border security agencies in South Africa to enhance border security. Partnerships between the public and private sector in the security arena are not a new phenomenon. As presented in Chapter 4 of this research, countries such as the USA, the UK, Angola, South Africa, Canada, and Nigeria have embraced the use of private security companies and PPPs for a variety of military and security-related operations and mission support activities (Kinsey, 2006).

The space industry has mirrored other sectors of the economy by introducing PPPs in several space applications, such as remote sensing, global navigation, international communication system, spaceports, and space solar power systems. This was done to enhance the efficiencies of space programmes and to grow a competitive domestic space industry (Howard, 2008). Moreover, in response to many developments in the space sector, such as the continuous need to remain abreast with new developments,

there has been a surge in private sector investment on resources dedicated for creating new commercial space capabilities and initiating the next wave of space exploration. NASA has also acknowledged the integration of commercial space capabilities for the implementation of space science missions, particularly for CubeSats and small satellites. NASA has since announced partnerships with US-based businesses to achieve some of its goals and to encourage the participation of the private sector in space projects (Klotz, 2017; Morse, 2017; Kennedy, 2019).

Space technology–based PPPs have also been realised in strategic sectors such as the military. For example, the UK and EU launched the Skynet 5 project in 2003 and the Galileo concession. The Skynet 5 project was considered because of the need to develop a military communication system that would replace the Skynet 4 satellites. As such, the UK government opted for a PPP, as it was believed that it would save the government £500m over the lifetime of the contract (Chuter, 2007; Betran & Vidal, 2005; Iron & Davidian, 2008). In another example of PPPs in the space technology sector, the US Department of Defence partnered with a private space company, Intelsat Ltd, and Cisco Systems to develop and introduce high speed internet access to various military units across the country, which are not tied to any location. In this arrangement, the initial funding for this project was achieved through private investment and private equity funding (Pasztor, 2008).

Other practical examples of PPPs in space technology projects, especially for military and civil operations (as discussed in Section 4.11 of this research), which could also be applied in the border security context, are the COSMO-SkyMed, TerraSAR-X, RADARSAT-2, and Skynet. The COSMO-SkyMed was planned for dual-use in military and civil earth observation systems. The TerraSAR-X is a German radar satellite, which is the product of a partnership between the German Aerospace Center and Astrium GmbH aimed at providing data for scientific research for the establishment of a commercial earth observation market (Werninghaus, 2004; Earth Online, 2020; Geoimage, 2020; During et al., 2008). As revealed during the review of literature in Section 4.11, South Africa, like other developed and developing countries, has the capability to undertake a variety of space projects. It relies on several organisations, including private companies, academic institutions, science councils and research-based institutions, to design and develop space technologies. As indicated by

various authors, South Africa has the capability to develop and manufacture its own satellites through effective collaboration with academic institutions and space companies (Dahir, 2018; Scatteia et al., 2020; PMG, 2017; Wood & Weigel, 2012; South Africa, 2020).

Given the above, almost all the participants concurred that there should be partnerships between the private space technology industry and border security authorities in South Africa to enhance border security through the application of space technology. The participants mentioned several benefits that could be realised through effective partnerships, as presented in Section 6.2 of this study. The benefits, mentioned by the participants, were in line with the views of various authors (as presented in Chapter 6), which consisted of the sharing of expertise; the enhancement of border security; expedited technology innovation; and private sector financing. For example (see Section 6.24 of this study), the Minister of Defence acknowledged that South Africa is a major producer of UAVs, and much of the intellectual property, which resides within South Africa, is held by state-owned entities and the private sector.

Moreover, a participant said (see Section 6.3.1.4) that partnerships with the private sector were crucial because, with the regular advancements in technology, the government would not be able to work alone on technological issues, but would have to rely on the private sector, which was more capable and had business interests to control. The participants also mentioned that partnerships would result in financial, and costs benefits for the private space technology industry and the government. This is similar to the views held by some authors, as contained in Section 4.11, who indicated that countries (e.g., the UK) have opted for PPP in space projects, such as the Skynet 5, as it was believed that it would save the government millions of euros over the lifespan of said project.

Although the review of literature and the views of the participants in this study supported the idea of implementing partnerships for border security space technology projects, the participants also indicated that the envisaged partnerships would not be without challenges. The participants, particularly the border security officials, identified a number of challenges that could inhibit the effective implementation of the envisaged partnerships. The participants opined that the private sector would not be

interested in engaging in such partnerships due to lengthy government processes, among others. Another issue of concern raised by the participants was the cost implications for the public sector, which would discourage the public sector from engaging in such partnerships. Other participants raised security concerns, indicating that border security was a function of government, and the private sector should not be involved. The participants further indicated that the involvement of the private sector might compromise border security information and mission security.

In addition to the possible inhibitors, mentioned earlier, other participants mentioned corruption, a conflict of interest, and the risks of the envisioned partnerships. These views were similar to those mentioned in Section 4.5.2 by various authors who stated that PPPs were not immune to corruption and that PPP corruption could occur at any stage of the PPP (Sclar, 2000; Liu & Mikesell, 2014; Wells, 2015). On the risks of a conflict of interest, the authors suggested that a conflict of interest in a PPP was more likely when the different PPP functions created opposing incentives for each of the contracting partners. In this instance, the public partner would normally push for lower prices; while the private partner would likely push for maximising profits (Thia & Ford, 2009). In addition, other authors indicated that the private sector would only make it easy for the government to obtain finance if the financing of the project would result in returns on investment (World Economic Forum, 2005). These risks and inhibitors clearly require the implementation of effective governance and project risk management protocols to not only prevent these risks associated with the envisaged PPPs, but also to detect them when they occur.

Considering the valuable benefits of PPPs, as stated by the research participants and the various authors as contained in the consulted literature, the creation of partnerships between border security entities and the private space technology sector for the enhancement of border security becomes critical, considering that South Africa has a strong private space technology sector (see Section 4.11). South Africa also has a history of effective partnerships between the private space technology sector and the public sector. This is evident in the development of various satellite technologies and the launching of satellites over the years (see Section 4.11); for example, the development of Sunsat, Sumbandila and Tshepiso through effective collaboration with

academic institutions and space companies (PMG, 2017; Wood & Weigel, 2012; South Africa, 2020).

Moreover, South Africa has a strong private UAV industry and is a big producer of UAVs. This was acknowledged by the Minister of Defence who said that, considering the abundance of available and developing technologies, these technologies could be enhanced to meet at least 60% of South Africa's technology localisation for the purpose of realising its border security needs (Kesteloo, 2019; DefenceWeb, 2017). Major role players in the South African UAV industry are Denel and CSIR. Denel manufactured the Seeker 400, equipped with sophisticated systems, which could be used for aerial surveillance, while the CSIR developed Indiza, a small hand-launched drone equipped with various camera modules, a 3G mobile phone-based camera, and a towable high-definition wide-angle video camera, which could be used for border security missions (Martin, 2018; CSIR, 2019; Martin, 2019).

From the above interpretation of the research findings, it is clear that the participants fully grasped the various threats and risks of border security in South Africa. The participants also full comprehended the nature of the challenges of border security in South Africa. In addition, the participants acknowledged that space technologies could be of value in enhancing border security in South Africa. They also indicated that the border security task could be achieved with relative ease if there were effective partnerships between the government and the private space technology industry.

7.6 Chapter Summary

This chapter provided an interpretation of the research findings and evaluated the emergent sub-themes against the pre-defined themes of the threats and risks of border security; the challenges of border security; space technology for border security; and partnerships between border security authorities and the private space technology sector. The reviewed literature was also presented in support of each emergent subtheme. The participants appeared to have a very good understating of the threats and risks of border security in South Africa. Furthermore, the views of the participants in this regard were consistent with the reviewed literature. There were also significant similarities between the collective views of the participants and the appropriate

theoretical framework on the challenges of border security in South Africa. Considering this, the participants' viewpoints, as supported by the literature, suggested that there was a need to employ space technology to enhance border security in South Africa. There was also a common understanding among the participants, and it was further supported by the literature, that there should be partnerships between the government, the private space technology industry, and other private partners for the development of suitable space technology for border security. The next chapter provides a summary of the research findings; furthermore, it provides recommendations and presents a conclusion.

CHAPTER 8

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

8.1 Introduction

The aim of this research was to examine the practicability of employing space technology to address border security challenges on South Africa's international land borders. It further sought to explore the opportunities of forming effective partnerships between the public sector and the private space technology sector to address land border security challenges in South Africa through the application of space technology. In this chapter, the researcher will present a summary of the research findings in the context of the research questions, as indicated in Chapter 1 of this study. The chapter will also present the conclusions based on the findings of the research. Thereafter, the researcher will propose a model for PPPs for border security, followed by the recommendations of this research, and recommendations for further research.

This study has found that South Africa faces a mammoth challenge of managing and controlling its porous international land borders. Border jumping; human smuggling and trafficking; the smuggling of goods; and stock and vehicle smuggling across the land borders are prevalent in South Africa. Several factors, including the vastness of South Africa's land borders, variations in the land border terrain, and inadequate human and physical resources make it difficult for South Africa's border authorities to effectively safeguard, monitor and control the land borders. Based on the findings of this research, it could be concluded that the current application of conventional methods of border safeguarding, control and monitoring, such as foot and vehicle patrols, and fixed observation posts, could be regarded as inadequate and ineffective in curbing the scourge of illegal cross-border activities along South Africa's international land borders.

Given the above, the researcher sought to explore the utilisation of space technology to safeguard, monitor and control South African international land borders. The researcher also sought to determine the extent to which PPPs between the private space technology industry and the public border security sector could be implemented to enhance land border security in South Africa through the application of space technology. Therefore, the aim of this research was to:

1) To examine the nature of border security threats and risks in South Africa;

2) To identify the challenges of controlling and monitoring South Africa's land borders;

3) To explore the practicability of employing space technologies to enhance land border security in South Africa;

4) To explore the role the private space technology industry, together with the public border security sector, could play in enhancing land border security in South Africa; and

5) To suggest a policy framework for enhancing land border security in South Africa through effective partnerships between the public border security sector and the private space technology industry.

This chapter seeks to consolidate the answers to the below mentioned research questions and to further propose solutions to the challenges identified in this research:

1) What are the current threats and risks to border security in South Africa?

2) What are the current challenges of monitoring and controlling the land borders in South Africa?

3) To what extent can space technology be applied to enhance land border security in South Africa?

4) To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

This chapter will begin with a brief overview of all the preceding chapters, followed by a summary of the key research findings. Thereafter, the researcher will propose solutions to the problem at hand, provide recommendations, and make conclusions.

8.2 Chapter overview

In this chapter, the researcher will begin by recapping on the preceding seven chapters. The researcher will provide a brief overview of each of the preceding chapters.

8.2.1 Chapter 1: General orientation to the topic and thesis

This chapter was intended to briefly introduce and contextualise the research at hand. It commenced by providing a short background to the study. It also discussed the research objectives and the research questions. Thus, this chapter presented the conceptual framework that underpinned this research. The primary aim of this research was to examine the practicability of employing space technology to address border security challenges on South Africa's land borders.

This chapter further sought to explore the opportunities of forming effective partnerships between the public sector and the private space technology sector to address land border security challenges in South Africa through the application of space technology. In addition, this chapter also highlighted the significance of the research. The researcher then proceeded to clarify the key concepts applicable to this study, such as border security, space technology, and PPPs. The chapter concluded with a brief overview of this thesis.

8.2.2 Chapter 2: Border security in the context of South Africa

This chapter discussed the general theories of border security. Moreover, the chapter explored illegal migration trends in selected countries and the extent of illegal

migration in South Africa. This chapter also focused on the general approaches to border security in the country. It further examined the legislative framework and institutional arrangements applicable to border security in South Africa. Moreover, the chapter focused on the challenges of illegal migration border and the implications of poor and ineffective border control measures. Other critical aspects discussed in this chapter included the socio-technical aspects of border security. Thus, this chapter served to explore the critical issues related to this research by exploring practical challenges experienced by border security authorities in South Africa. This chapter further served to support the notion that there are challenges related to border security in South Africa and it further sought to support the idea that the application of space technology for border security should be an option to be considered by border security authorities.

8.2.3 Chapter 3: Space technology and border security

Chapter 3 focused on the general theories of space technology and the application of various space technologies for civilian and commercial purposes. It also examined the aspect of space technology in developed and developing countries. Additionally, this chapter discussed the history of space technology in South Africa and the country's capability to develop space technologies, such as UAVs and satellites. It also explored the various space-based technologies, which could be developed or acquired to enhance border security in South Africa.

8.2.4 Chapter 4: Public-private partnerships

In this chapter, the researcher reviewed the literature using various sources of secondary data. The literature review focused on theories underpinning PPPs; the application of various PPPs models intercontinentally and continentally; and the application of PPPs in space and in homeland security projects. This chapter highlighted that South Africa has implemented a few PPPs projects in sectors such as correctional services, recreational parks, roads, and hospitals.

Chapter 4 also highlighted that partnerships between the government and the private sectors have entered strategic sectors such as public safety, national security and the military. It further highlighted that the USA and Europe have made efforts to build close partnerships between the public and private space sectors in the realisation of space projects. Additionally, this chapter revealed that South Africa, like other developed countries, relies on private companies, academic institutions, science councils and research-based institutions, which design and develop space technologies.

8.2.5 Chapter 5: Research methodology

This chapter provided an overview of the processes followed by the researcher to conduct this research. Firstly, this chapter distinguished between the various philosophical worldviews. It also discussed the rationale for selecting a qualitative approach towards this research in line with the different philosophical worldviews. This was followed by the research design and approach applicable to this research. The chapter also presented a comprehensive description of the population relevant to this research together with the sampling strategy, which unfolded during this research. The researcher then proceeded to provide an explanation of how the data collection and data analysis processes unfolded during the research process. The chapter also discussed the strategies employed by the researcher to ensure the overall trustworthiness of this research. Lastly, ethical considerations and issues of confidentiality were reviewed in this chapter.

8.2.6 Chapter 6: Presentation of the research findings

In this chapter, the researcher presented the findings of the documentary sources and the various semi-structured interviews conducted with the research participants. Therefore, in this chapter the researcher aimed for an understanding of the phenomenon from the expressed views of the research participants and the proposed technological solution to the provision of effective border security in South Africa. The data analysis process unfolded against the predetermined themes, which included the threats and risks to border security in South Africa; border security challenges in South Africa; space technology for border security; and PPPs for border security in South Africa.

Other themes, such as the challenges of employing space technology for border security and the potential challenges of adopting PPPs, also emerged during the presentation of the research findings. Moreover, various subthemes emerged against the main themes, which were presented using tables consisting of the subtheme, its frequency, and its frequency proportional to other subthemes. The subthemes were also presented in pie charts displaying the percentage of the subtheme proportional to other subthemes. These were supported by a brief discussion and direct quotations of the participants' viewpoints on a particular subtheme.

8.2.7 Chapter 7: Interpretation of the research findings

Chapter 7 was directed towards interpreting and synthesising the data collected in this research in relation to the relevant literature and theoretical underpinnings related to this research. Further to this, the researcher equated the perceptions and understandings held by participants with the relevant literature, as presented in Chapters 2, 3 and 4 of this study. The researcher also pointed out significant discrepancies and similarities between the literature and the viewpoints of the participants. From the above process it emerged that the collective understandings held by almost all the participants on the threats and risks to border security in South Africa; the challenges of border security in South Africa; the application of space technology to enhance border security in South Africa; and the adoption of PPP to achieve border security objective through the application of space technology were in concurrence with the consulted literature.

8.3 Summary of the key research findings

This section is intended to review conclusions derived from the data analysis and interpretation processes and to present feasible recommendations for establishing a best practice model for border security in order to enhance border security in South Africa. The recommendations of the research participants will also be taken into consideration when presenting the final recommendations. In addition, the researcher will make use of the recommendations made by various speakers during a two-day conference on unmanned aviation held in November 2020 in Johannesburg, South Africa. The conference focused on developments in the unmanned aviation industry in

South Africa. Different themes were discussed by various specialists and experts in the field of unmanned aviation. The researcher requested permission to use the minutes of the conference for this research. Although the researcher did not ask specific questions, as contained in the interview schedule, the various speakers at the conference extensively presented and discussed many aspects related to this research and the research questions in particular. Features, such as the use of UAVs in border security and the need for partnerships between the private UAV sector and the public sector, and the challenges and opportunities of the application of UAVs in a variety of industries in South Africa, were extensively covered by the various speakers at the conference.

8.3.1 Threats and risks to border security in South Africa

In general, this research confirmed that South Africa continues to experience an array of cross-border criminal activities at its international land borders. In reaching this conclusion, the researcher closely examined the information contained in documentary sources and the responses provided by the various research participants against this line of enquiry. The analysis revealed that the participants had a thorough understanding of the various threats and risks to border security in their respective areas of operation. Similarly, the documentary analysis processes highlighted similar understandings of the threats and risks to border security as presented by the border security officials and border security experts interviewed for this research. In the main, the documentary sources and the responses of the participants highlighted threats and risks, such as migration-related crimes, comprising illegal border jumping and human smuggling; cross-border smuggling activities, including the smuggling of goods, drugs, small arms and explosives; and cross-border livestock theft and smuggling.

Other cross-border criminal activities revealed in this research were the poaching and smuggling of wildlife and other natural resources crimes. The poaching and smuggling of wildlife, such as rhinos, mainly occurred in border areas situated close to nature reserves, such as the KNP and other nature reserves located near South Africa's borders. In other instances, wildlife crimes and the illegal extraction of natural resources occurred far from South Africa's borders, but these illicit goods were smuggled through South Africa's borders into neighbouring countries with the

possibility of being transported abroad. There was little reference to terrorism as a threat and risk to border security in South Africa, as opposed to countries such as the USA. In this instance, only one participant mentioned terrorism as a potential threat and risk to border security in South Africa. The review of literature suggested that one of the threats and risks to border security was the spread of communicable diseases. However, none of the research participants in this research identified this factor as a threat and risk to border security in South Africa. The spread of communicable diseases becomes a factor when people and animals cross the border into South Africa through undesignated ports of entry. These illegal cross-border activities deny port health and agricultural inspectors the opportunity to conduct the necessary screenings on persons and animal entering South Africa. This aspect has become relevant in recent times during the COVID-19 pandemic, with one example being the urgent erection of a fence along the South Africa-Zimbabwe borders to curb the spread of COVID-19.

Given the above, it could be concluded that South Africa faced several threats and risks to border security at its various international land borders. It was also ascertained that some threats and risks to border security were more prevalent in some border areas than in others. For example, cross-border livestock theft was said to be more prevalent on the South Africa-Lesotho borders, whereas illegal border jumping was more prevalent on the South-Africa-Zimbabwe, South Africa-Mozambique, and South Africa-Lesotho borders. The review of literature provided little insight regarding the nature of the border security threats and risks on the South Africa-Namibia and the South Africa-Botswana borders. Available literature suggests that these are the least problematic border areas, when compared to the borders with Zimbabwe, Mozambique, Lesotho and eSwatini. This was attributed to the strong institutional architecture present in those countries as opposed to countries, such as Lesotho, which have a laissez-faire approach to border security and perhaps, little interest in managing their borders.

8.3.2 Challenges of border security in South Africa

The research found that current border security measures are ineffective and unable to curb an array of cross-border criminal activities. The threats and risks to border security in South Africa, as discussed in the preceding section of this research, are caused by a

number of factors present in the South African border security architecture. In this line of enquiry, the research sought not only to understand the challenges of border security in South Africa but also sought to identify the causes of those challenges. Therefore, the analysis of the challenges of border security were assessed from the policy and legislative framework perspective; command and control perspective; technical perspective; and human resources perspective.

Collectively, the participants, the documentary sources, and the consulted literature all attributed the challenges to border security in South Africa to an array of factors. These factors could be associated with the socio-technical aspects of border security consisting of governance structures and processes; the human factors of border security; as well as the non-human factors of border security. This research found that as early as the advent of democracy, South Africa was struggling to put in place effective border security management structures. The research further found that effective co-operation among the various government departments involved in border control was lacking. The lack of proper and effective cooperation and communication at all levels of border security management were found still to be prevalent in the South African border security environment.

The study also found that existing border control structures were not effective in coordinating the activities of the different departments in the border security environment. These challenges continued to exist despite the existence of several border security coordinating structures at the Cabinet level down to the lowest operational level. Some of the authors attributed these challenges to a silo mentality where the respective departments sought to protect their own individual interests at the expense of other departments in the border security environment. They lacked a broader vision of a highly secure border environment and effective border security management.

In addition, the current institutional arrangement was not enforceable in the absence of a legislated border security management paradigm. These aspects were also noted by some of the research participants as critical factors that impeded the provision of effective border security in South Africa. Thus, a fully effective border security management structure and strategy was lacking in South Africa. The current multi-

departmental approach to border security remains a critical hindrance in the provision of effective border security in South Africa. However, the recent passing of the BMA Bill into law and the anticipated establishment of the BMA soon could address legislative and institutional challenges and gaps of border security management in South Africa, as identified herein.

In further assessing the challenges of border security in South Africa through the analysis of a multitude of socio-technical aspects of border security, as contained in the reviewed literature, documentary sources and the expressed views of the participants, the research further identified the socio aspects of border security, including human resources constraints, as a major challenge of border security in South Africa. It was deduced from the available literature and the expressed views of the research participants that border security authorities and the SANDF relied heavily on human resources to execute their border security mandate. The study further established that the current SANDF's border security force levels were inadequate to provide effective border security. The SANDF only had 15 companies for border safeguarding, instead of the required 22 companies; it also lacked adequate resources, such as specialised patrol vehicles and equipment, to deliver on its border security mandate.

The lack of adequate human resources and other resources resulted from the continuous underfunding of the SANDF, which prevented it from acquiring and deploying adequate resources and personnel for the border security function. The SANDF has experienced consistent budget cuts over the years, which negatively affected its ability to fulfil its constitutional mandate, including the one of border safeguarding. In this regard, senior members of the SANDF, including the Minister of Defence, have repeatedly raised concerns over the underfunding of the SANDF and have consistently requested additional funding from the government. Another socio aspect of border security-related personnel, which was mentioned by a significantly lower number of participants but adequately exposed during the literature review, was corruption. Corruption has exacerbated the current border security challenges in South Africa. Through corruption, cross-border criminal activities such as border jumping, and human smuggling can be executed with relative ease. As highlighted in the literature, the success of any border security system largely depended on the integrity, honesty

and ethics of border officials. Therefore, corruption among border officials tends to weaken the objective of the entire border security regime.

It has been noted that the border environment in South Africa is characterised by harsh terrains and unfavourable road conditions, which makes it extremely difficult for border security authorities to patrol using conventional measures such as foot and vehicle patrols. The evidence in this research further indicated that the land border terrain in most parts of the border area in South Africa is long and open, densely populated and mountainous and bushy, which has proven to be too difficult for border authorities to monitor and control. Moreover, the evidence in this research pointed out that the roads along the borderline are inaccessible making it extremely difficult, if not impossible, for authorities to conduct the necessary monitoring such as foot and vehicle patrols. The length of the South African borders is more than 4700 kilometres. Certainly, it is impractical to have human resources posted in each area of the borderline, day and night, to prevent cross-border criminal activities. This inability, coupled with the absence of a borderline fence in most parts of South Africa's borders, offers criminal elements and other persons an opportunity to cross into and out of South Africa.

Thus, it can be concluded that the extent of the threats and risks of border security as identified earlier in this study is as the result of the inability of South African border security authorities to exercise control over the borders. If not correctly addressed, this situation could fuel further challenges of instability and national insecurity in South Africa, as suggested by available literature. Moreover, it will hamper South Africa's ability to discharge its responsibilities within its territory and hinder it from achieving its political, legal and economic objectives. Thus, the issue of effective border security, which is a critical factor of national security, becomes a key national security problem for consideration by South Africa.

8.3.3 Application of space technology to enhance border security in South Africa

The function of border security comprises a combination of numerous socio-technical aspects related to this function. Technology has been identified as one of the most important socio-technical aspects of border security. Many developed countries rely

on hi-tech assets to control and monitor their international borders. They use many technological solutions to prevent cross-border criminal activities, such as illegal migration and the smuggling of drugs and narcotics. This study investigated the possibility of utilising space technology to enhance border security in South Africa. It looked at the various benefits of utilising space technologies for border security. It also examined the potential challenges of the application of space technologies for border security. This research acknowledged that international best practices might not necessarily be implementable in the South African context due to several unique factors, which were identified by the research participants.

The objective of employing technology in any security system is mainly to implement fundamental security solutions, which could enhance the level of security to the desired levels in any given security context. Similarly, the utilisation of technology in the border security environment seeks to augment existing border security measures and ultimately enhance the level of border security. This research focused on the application of space technology for border security and revealed that UAVs and satellites could be and should be used for border security in the South African context. The research established that the use of these technologies, together with other technological solutions such as radars and sensors, could achieve better border security results. This research also pointed out that these technologies could form part of the comprehensive socio-technical components of border security. These socio-technical components could involve humans, UAVs, satellites, aerostats, radars, manned aircraft, ground vehicles, cameras, and boats. Nevertheless, these technologies do not seek to replace other technological solutions and human resources but seek to augment these measures. Only in instances where measures have proven to be entirely ineffective, they could be replaced by other solutions. Thus, space technology only allows for the modernisation and improvement of border security measures.

It is also worth pointing out that even though this research supported the use of UAVs and satellites for border security, UAVs received more recognition than satellites due to a number of factors, including cost and effectiveness. The research further established the advantages of UAVs; namely, that they were cheaper than satellites and they could be controlled by a single operator, thus, reducing personnel-associated costs. UAVs were also identified as fast technological solutions, which could patrol

large border areas. They also had a wider area of visibility than conventional surveillance methods, such as human eyes, which increased the probability of detecting illegal cross-border movements.

The successful execution of border security activities also depended on extensive information about the targeted area. It further required the extensive sharing of information among various organs or components of border security management. As such, UAV could perform intelligence, surveillance, and reconnaissance missions. They could also be used for other purposes, such as the delivery of supplies to border guards in remote areas. Moreover, their ability to feed real-time images and to follow a target being pursued in harsh and thinly populated terrains provided them with an advantage over vehicles and foot patrols.

The harsh and dangerous terrain in most parts of the South African borders exposed border guards to a few dangers. Accordingly, the use of UAVs in the border security environment could limit the exposure of border security officials to occupational hazards associated with foot patrols, such as encounters with wild animals, operating under extreme weather conditions, walking, or driving in unfavourable terrains that might cause injuries to border guards on patrol, or conducting physical patrols and surveillance activities at night in dangerous situations. When live images and videos were fed to the local command centre through UAVs, the command centre could dispatch adequately equipped response personnel, based on the threat and risk identified by the UAV.

Despite all these benefits, this research also revealed that the utilisation of UAVs for border security in South Africa would not be as easy as anticipated. The research pointed out some of the factors to be considered by border security authorities. The factors included the regulatory framework, which was widely regarded as a potential obstacle. The UAV industry and the utilisation of UAVs are highly regulated in South Africa. The CAA sets out conditions under which UAVs can operate and the applicable safety standards. It also imposes penalties for non-compliance with the applicable laws and regulations. Other issues for consideration revealed in this study on the utilisation of UAVs were the cost implications associated with the procurement, operation, and maintenance of UAVs. The research also pointed out that the operators of UAVs would

need to be trained, which would escalate the costs of utilising drones. Thus, the decision to utilise UAVs for border security in South Africa should be based on a comprehensive cost-to-benefit analysis. Ignoring the value that UAVs could add to border security and preferring to stick to old and ineffective methods of border surveillance were also identified as other critical factors that could hamper the full utilisation of UAVs for border security in South Africa.

Satellites were also identified by this research as potential solutions to the problem of border security in South Africa. They could add value in border security through the provision of earth observation, remote sensing, and navigation and communication capabilities. This research further found that satellites could provide border security authorities with detailed images of high-risk areas with an increase in illegal border crossings. They could also conduct wide area surveillance, as well as access remote border areas. Satellites could further be used in a variety of activities, including monitoring targeted border areas, disaster management, as well as search and rescue missions. Images obtained from satellites could help border security authorities to detect illegal trafficking paths along a country's international borders. Moreover, this research pointed out that regular traffic across a border area interfered with vegetation and soils and was likely to leave visible tracks that could be detected remotely by orbital sensors. The ability to gather intelligence was a critical component of a border security system. This allowed border security authorities to have a good knowledge of their area of operation and further enabled them to be proactive in their border security operations, as pointed out by this study.

Notwithstanding the various benefits offered by satellites, in assessing the potential drawbacks of utilising satellites for border security, this research established that South Africa might not be in the financial position to utilise satellites for border security. It was revealed in this research that the country would require dozens of satellites fitted with high-resolution cameras to monitor the borders, which would result in huge financial expenses. However, it was also established that the costs of developing and launching satellites had dropped significantly in recent years, especially with small satellites like CubeSats and nanosats. Considering South Africa's capability of developing and launching satellites, including microsats such as Sumbandila, nSight1

and ZA-Aerosat, these capabilities could be exploited to develop affordable satellites that could be used for border security.

Another drawback associated with the use of satellites was their effectiveness to detect small items, such as people crossing a border. It could also be difficult to discern between people and animals, if using a satellite. It was pointed out that these drawbacks could be addressed by developing more expensive satellites, which were fitted with sophisticated high-resolution cameras. Considering the costs implication of developing, launching and utilising satellites for border security in South Africa, it might not be beneficial to utilise such technologies for live border monitoring. Satellites could, however, be utilised to detect illegal trafficking paths along the country's international borders by identifying and assessing regular traffic across the border, which usually interfered with vegetation and soils, and were likely to leave visible tracks that could be detected remotely by satellite technologies.

Evidence from this research pointed out that both satellites and UAVs could be integrated with other socio-technical aspects of border security. The evidence further indicated that other technologies, identified in this research, such as ground sensors, radars and cameras, all linked to a central command centre could be integrated with these space technologies for the provision of better and effective solutions to South Africa's border security challenges. The human element of the socio-technical aspects of border security would remain relevant in this setting. Border security guards would still be required to respond to border security incidents and to operate those technologies.

8.3.4 Public-private partnerships for enhancing border security in South Africa through space technology

Partnerships between the public and private sectors continue to play a critical role in the provision of various public goods and services. This research found that many countries, including South Africa, were turning to PPPs to offer goods and services such as education, hospitals, water, correctional facilities, roads and electricity. PPPs were also identified in public safety initiatives, such as policing and security. It was

also established that PPPs have entered strategic sectors, such as the military and defence. Another sector that has seen the emergence of PPPs is the space technology sector. This research further noted that advanced economies, such as the USA and Europe, were making use of PPPs to expand their space technology capabilities. These partnerships were seen in the development and launching of space applications, such as remote sensing, global navigation, international communication systems, spaceports and space solar power systems. Thus, this approach, as followed by these advanced economies, allowed for the expanded participation of the private space sector, which in turn resulted in efficiencies of their various space programmes and further fostered the competitiveness of their domestic space industry.

In exploring the extent to which PPPs could be adopted to enhance border security though the application of space technology in the South African context, this research sought to assess a few critical issues. Firstly, it sought to assess the possibility of collaborations between the South African border security authorities and the private space technology sector for the provision of technological solutions for border security in South Africa. It also sought to assess the type of partnership to be adopted; the opportunities of forming such a partnership; as well as the potential challenges of such envisaged partnerships. Evidence in this research suggested that there were opportunities for the South African border security authorities to collaborate with the private space technology sector for the provision of space technologies to be used for border security in the country. This type of partnership would look at aspects of space technology research and development; space technology innovation; skills transfer; and the sharing of expertise. Moreover, this research found that the envisaged partnership could result in mutual benefits for both parties in the sense that it could alleviate financial pressures that could be experienced by the government in procuring hi-tech assets such as satellites and a fleet of UAVs, whilst at the same time, resulting in economic benefits for the private partner. It was also highlighted by the research that PPPs would provide border security technological solution faster than traditional public procurement methods. They would also allow for the development of specific and suitable space technologies based on the needs of the border security authorities. Another benefit offered by the envisaged collaboration was the ability to integrate a variety of technological systems, resulting in enhancement border security.

As much as this research revealed a significant number of benefits of implementing PPP for the development of space technologies for application in border security in South Africa, it also revealed potential challenges of engaging in such partnerships. It highlighted policy issues that could hamper the implementation of such partnerships. The study also suggested that the private space sector might lack the necessary appetite to engage in such partnerships due to the budgetary constraints faced by the government; thus, it might be risky for them to engage in such partnerships. The issues of corruption and a conflict of interest were critical factors also identified by this research as potential inhibitors of engaging in the envisaged partnership. Another important negative factor uncovered was the security implications of involving a private partner in national security projects. The study indicated that border security missions involved the collection and handling of sensitive security data. Therefore, involving a private partner in high security activities might compromise mission security if no effective risk management strategies were in place.

8.4 Border security solutions for South Africa

This section of this chapter is the main part of the research. It addresses the two main research questions namely:

- To what extent can space technology be applied to enhance land border security in South Africa?

- To what extent can partnerships between border security authorities and the private space technology industry be implemented to enhance land border security in South Africa through space technology?

The goal of this section of the research is to propose a model for enhancing border security through the application of space technology and the adoption of PPPs in the South African context. The proposed border security solutions will be drawn from the contributions of the research participants, the review of literature, and comparisons with international best practices on border security and PPPs in space projects, as

discussed in the preceding chapters. The researcher will also draw on his professional experience on matters of border security in South Africa.

8.4.1 Space technology for border security

Some of the factors affecting the provision of effective border security in South Africa were identified as regulatory and structural issues. In this instance, the absence of a clear border security policy coupled with a lack of an effective border security strategy, and a fragmented borders security approach rendered it difficult to ensure effective border security in South Africa. Nonetheless, there has been some progress in the development of a consolidated structure of border security management in South Africa. The passing of the BMA Bill into law in 2020 has paved the way for the establishment of a single border security entity, which will coordinate and take responsibility for all border security management activities in South Africa. Thus, the challenges related to a fragmented border security management architecture will be addressed through the formation of the BMA. However, this will not resolve other challenges in providing effective border security, such as the strategy and the associated socio-technical issues. Hence, a holistic approach is required to reduce illegal immigration; human trafficking; the smuggling of goods; wildlife poaching and smuggling; and the spread of human and animal-borne diseases across South Africa's borders. In this discussion, the research will focus on the future role of the BMA and provide recommendations on the use of space-based technologies for effective border security in South Africa.

It was established that both developed and developing countries are turning to space technologies, such as satellites and UAVs, to control and monitor their international borders. It was also found that the current border security measures and methods employed by the South African border security authorities are not effective in addressing South Africa's border security challenges. Conventional methods of border control and monitoring are unable to address a variety of border security threats and risks, as identified in this research. Thus, it can be concluded that the current situation in South Africa has grown beyond the capabilities of conventional border security measures, as currently employed by the South African border security authorities

consisting of human, equestrian and vehicle patrols, as well as official manned checkpoints at land borders. It has to been acknowledged by this research that the adoption and utilisation of various technologies for border security should be guided by a border security strategy. As proposed by Mahlangu (2016), the border security model in South Africa should be based on policy and institutional settings, effective coordination and cooperation, as well as community involvement. The author (2016) adds that the border security strategy must be informed by the broad government policy.

Given the above assertions, national priorities become an important determinant of the government's motivation to invest in effective border security assets and technologies for the enhancement of border security in South Africa. In addition, from the researcher's perspective, not much can be achieved in the absence of a proper and effective border security strategy. Thus, it become imperative to have a properly formulated border security doctrine, which will define the specific border security roles, such as the operational control of the border security function; the deterrence strategy; and the risk management strategy. The strategy should also be intelligence driven to ensure the optimal utilisation of resources. Likewise, it should provide for the sourcing of a combination of socio-technical aspects of border security consisting of infrastructure, technology, and personnel.

Figure 8.1 provides the researcher's interpretation of the major influencers of a border security doctrine. Doctrine is defined as a fundamental set of principles that guides security services while in pursuance of their national security objectives (Rand, 2020). This becomes more relevant when South African is gearing towards the establishment of the BMA. These influencers mainly consist of past border security experiences, such as the challenges and successes with due consideration to the various issues and challenges of border security, mentioned in Section 2.6; global technological developments and the influence of technology on the attainment of border security objectives, as critically discussed in Section 2.3.3 and Section 3.5; operational and tactical requirements, mainly discussed in Chapter 6 and 7; and individual and collective experiences, such as the integration of various organs of state on border security management matters, discussed in Section 2.3.1.

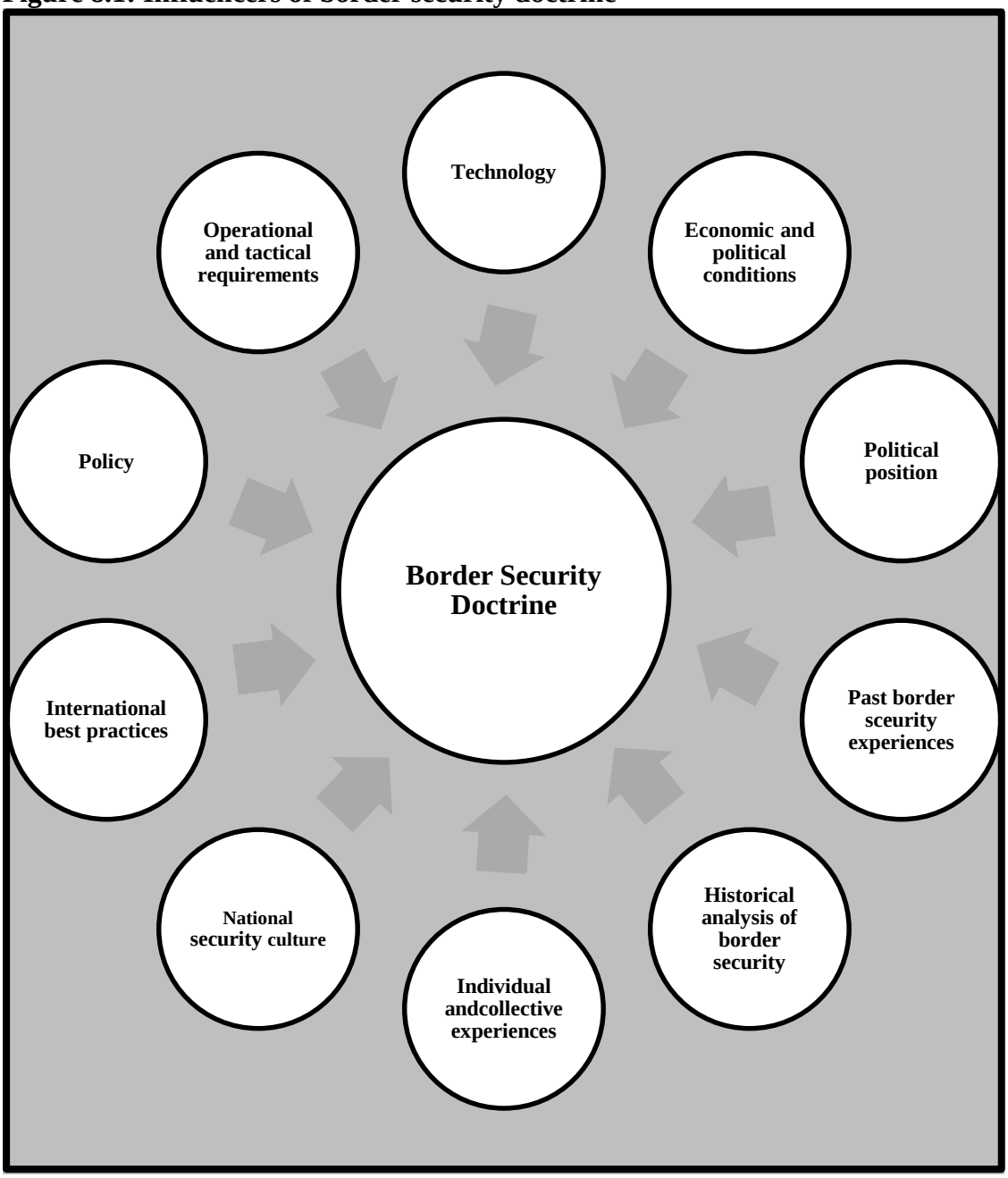
More importantly, the border security doctrine in South Africa could be influenced by the political and economic conditions in the local, regional, and international arena. As stated in Section 2.6, dire economic conditions, and political instability in many countries in Sub-Saharan Africa and beyond fuel massive migration into South Africa. This factor will also shape South Africa's migration management and border security approach. The national security culture of South Africa will also influence the border security doctrine. Considering this, it should be mentioned that approaches to border security in South Africa pre-democracy and post-apartheid are completely different.

The level of threats and risks that were present and perceived by apartheid South Africa differs from the threats and risks of border security experienced by a democratic South Africa. Therefore, these developments will require the adoption of a border security culture that is aligned to the Constitution and commensurate to the rule of law; considers the varying humanitarian needs of migrants and other persons; and complies with international treaties whilst also ensuring that border security is not compromised. On the other hand, border security doctrine seeks to guide border security operations in order to contribute to South Africa's national security programme; and further provides a conducive platform for the effective discharge of South Africa's international obligations. It will also provide guidance on the execution of operational and tactical activities and the analysis of operational challenges; and further provide for the delivery of professional border security education and training.

Considering this influencers and roles of a border security doctrine, comprehensive and effective border security management solutions are required to address South Africa's current border security challenges. The adoption and reliance on technological solutions is most likely to be a game changer in the South African context, especially with border security authorities seeking to maximise on the utilisation of their human resources, financial resources, and physical assets. Therefore, an integrated border security monitoring system is required to solve South Africa's border security challenges. A variety of technological assets, as identified earlier in this research, should be integrated together with procedures and human resources to enhance the level of border security in South Africa. Patrolling long stretches of the South African borderline and the harsh border terrain in large parts of the border area using conventional methods, such as foot and vehicle patrols, has proven to be a daunting

task for the ill-prepared and under-resourced South African border security authorities. Thus, the adoption of technology seeks to address these challenges by providing economically yet effective border security solutions. Technological solutions specifically designed for the South African border security environment become a necessity to address the various and unique dynamics of the country's border environment.

Figure 8.1: Influencers of border security doctrine



Source: Researcher's own illustration

With the establishment of the BMA, there would be the need for the establishment of local, regional and national border security command centres. Considering this, lessons could be drawn from the current SANDF structure of the national and regional joint operation headquarters where each province has an established headquarter for the coordination of military operations. Other lessons can be drawn from the current functioning of the national and provincial joint operations and intelligence structures where all security and law enforcement operations throughout South Africa and the respective provinces are coordinated. Although the proposed national, regional and local BMA command structures do not seek to replace the current multidimensional security and intelligence structures, they will be responsible specifically for border security operations in South Africa.

The proposed BMA or border security command centres should be equipped with a variety of hi-tech border security assets. These assets should consist of intelligence, surveillance, reconnaissance, and border patrol technologies, as well as effective communication systems. It has been established that UAVs and satellites are more than capable of executing this daunting task of intelligence gathering, intercepting targets and border monitoring with relative ease compared to humans and vehicles. These technologies should be integrated with other technologies such as ground sensors, radars, and fixed and turn and tilt cameras. These technologies should further be aligned to human resources and command structures to synchronise BMA border security activities.

Since the various border areas in South Africa have unique sets of challenges and varying environmental conditions, these technological systems should be designed with due consideration to those various and unique characteristics and challenges of each of the border areas. For example, where illegal cross-border grazing is the main challenge, such technologies should be able to differentiate between human and animal movements; thus, allowing the command centre to dispatch appropriate responses. Therefore, the establishment of the BMA should be technology driven, where the use of technology and in particular UAVs for border security activities becomes an absolute consideration. Due to the huge cost implications, the use of satellites for border security in South Africa might be considered, but only for other border security activities – not including the live monitoring of South Africa's borders. Satellites could

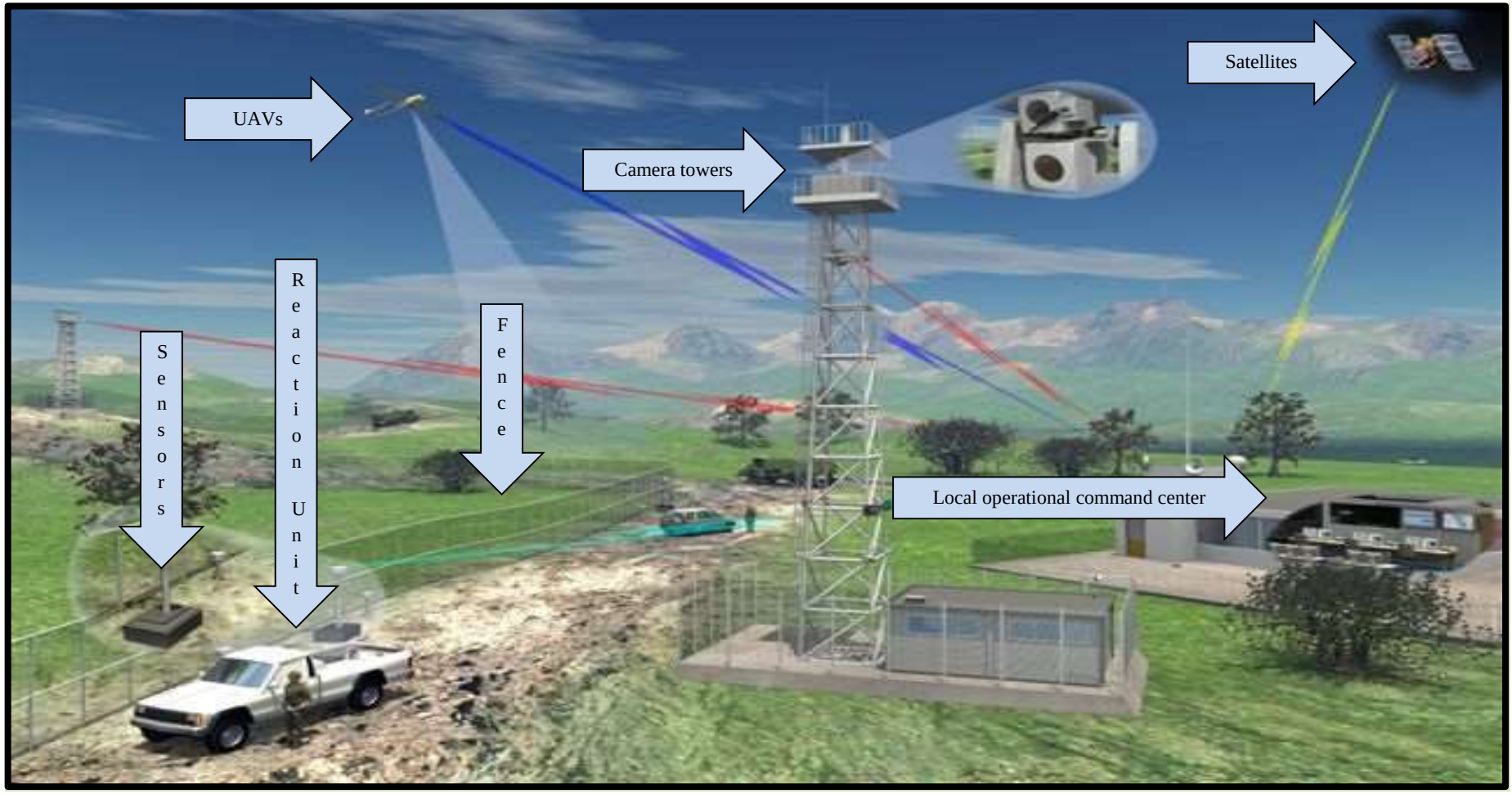
be used for the study of illegal border crossing patterns and trends in identified border areas. This would allow border security authorities to identify areas where illegal border crossing occurs frequently. Therefore, satellites could be considered for augmenting technologies such as UAVs, ground sensors, and cameras.

Satellites in the border security environment could also be used for communication, navigation, and global positioning. This will also be of benefit to many border communities and businesses who do not have or have limited access to telecommunication infrastructure and services. This implies that PPPs could contribute to the enhanced use of satellite communication (satcom) for public service. Satcom projects feature all the characteristics of a public infrastructure programme, characterised by huge investments in research and development, the manufacturing and launching of satellites, and the long operational lives of those assets.

Figure 8.2 depicts the integration of various socio-technical aspects of border security for consideration in South Africa. It describes how satellites, UAVs, cameras, radars, sensors and border guards could be integrated for a total border security solution in South Africa in order to give effect to a defined border security strategy. As indicated, the adoption of specific security assets for use in border areas would be dependent on the level of threat and risk exposure of a particular border area and the measures necessary to neutralise the identified threats and risks. This would ensure the optimal utilisation of resources.

The list of technological solutions and other border security assets, as depicted in **Figure 8.2**, is not exhaustive but seeks to provide a brief description of critical technological security solutions in line with the aim of this research. With the private sector playing a critical role in technological innovations and development, the next section of this chapter seeks to discuss how the private space technology sector could collaborate with the government, border security authorities, academic institutions, and other partners for the provision of the proposed border security technologies, particularly satellites and UAVs.

Figure 8.2: Integrated border security solutions



Source: Adapted from Commondreams.org (2020)

8.4.2 Public-Private Partnerships for enhancing border security through space technology

PPPs are known to bring together a variety of expertise from both the public sector and the private sector and they have been regarded as valuable vehicles for delivering infrastructure and services more efficiently than when the public sector does it on its own. It has also been noted that PPPs are not limited to infrastructure and services but have entered hi-tech industries such as satellites technologies and UAVs. They have also entered strategic industries including the military and defence. Drawing from the success of various PPPs projects globally and in South Africa, the researcher holds a strong view that there is a great opportunity to adopt PPPs for the enhancement of border security through the application of space technology in South Africa. The nature and structure of such a partnership would differ from most of the traditional PPPs approaches, as discussed in Chapter 4. According to Jones (2018), PPPs in space projects differ from traditional PPPs, which provide public infrastructure and services. The author (2018) states that in space projects PPPs are adopted to share risks and expertise through cooperative research and development, regulations, and long-term agreements. Thus, PPPs in space projects seek to leverage commercial sector innovation and agility.

The envisaged partnerships, as proposed by this research, seek to bring together the state, provincial and local governments, alongside private space technology partners and other private interests to accelerate the development and deployment of space technologies for border security in South Africa. State-owned enterprises, such as Denel, and research organisations, such as the CSIR, would be critical role players in this collaboration. Borders security agencies and provincial and local governments would be the end users of the assets emanating from the collaboration, alongside other private interests situated near border areas and affected by cross-border criminal activities.

The partnerships would seek to blend the various strengths of both the government and the private sector to solve border security challenges whilst providing economic opportunities to the private partners. Through the envisaged partnerships, private sector

capital use would be realised, as well as the creation of collaborative space technology integration strategies. Moreover, other government entities not directly involved in border security would likely derive benefits from such partnerships, together with other private entities situated along South Africa's borders, such as commercial farming communities, the hospitality sector, and asset management companies affected by cross-border criminal activities.

As established in this research, the private sector has the necessary finances and expertise, and is often the leader in technology innovation and development. Thus, partnerships would enable the public sector to capitalise on the strengths of the private sector for the development and delivery of the necessary hi-tech border security assets. As described by Jones (2018), PPPs in space technology projects allowed the public partner to capitalise on the financial and other resources held by the private sector.

The private sector, on the other hand, could use this opportunity to influence industry regulations, expand their market, derive benefits from the partnership as a result of innovation and technology spin-ins, and further strengthen their industrial base. Thus, the envisaged partnership would look at the various aspects of border security management consisting of border security mission support to advance issues of national security; the provision of functional support such as communication infrastructure; and technological advancement looking at continuous innovation and the development of border security technologies and other technologies for civil applications.

The need for collaboration in space technology project was also revealed during the Unmanned Aerial Systems (UAS) conference attended by the researcher on 24 and 25 November 2020 in Johannesburg, South Africa. It was established that the private UAV industry has noted with concern the lag time between sufficient policymaking and technology advancements in South Africa. The speakers at the conference were concerned about the time it took the government to make policy decisions about the UAV industry in South Africa. Another concern raised by the speakers at the conference included drone regulations, which were said to be an obstacle to the effective regulation of drones. They also mentioned that regulatory frameworks that would foster innovation and growth were needed in South Africa. The speakers further

called for flexibility in the drone regulatory framework to ensure that the drone industry in South Africa kept up with technological advancements.

Moreover, the speakers called for the creation of a healthy ecosystem in South Africa between the private UAV sector, the government, and the public. They further said that partnerships would be beneficial, as the end users could not cope on their own; the sector was also needed as it had the necessary resources, and the government should commit to creating an enabling environment. Moreover, the speakers said that partnerships were necessary to consider the aspects of sector growth, innovation, regulations, and incubation.

Similar to the adoption of PPPs in the acquisition and utilization of UAVs for border security as discussed earlier in this chapter, collaborations between the government, border security authorities, large satellite corporations, research institutions, and small and emerging private satellite companies also becomes important for the funding, design, and development of affordable and border security-tailored satellites for application in the South African context. Other options would be to utilize existing commercial earth observation satellites for border security purposes. In the latter, border security authorities and other partners may source the utilization of existing satellites through user-pay agreements. South Africa can capitalise on existing collaborations to develop satellites for application in border security.

As highlighted earlier in this research, South Africa is capable of developing and manufacturing its own satellites such as in the case of Sunsat, Sumbandila, and Tshepiso through effective collaboration with academic institutions such as and space various companies. Therefore, the localization of the development and provision of satellite technologies for application in border security in South Africa will enhance the delivery technologies that will be designed to specifically address local challenges while simultaneously encouraging the growth of the local satellite industry and SMMEs. Other benefits of utilising PPPs for in the provision of satellites for border security in South Africa would include economic benefits, the creation and retention of jobs, and skills development.

Moreover, it will result in the transformation of the satellite industry, improved technology offerings through new thinking, efficiency as well as cost savings. Thus, the utilization of both national and commercial infrastructure and capabilities is key to achieving a variety of national economic and societal objectives including border security; communication; navigation, asset tracking; internal migration and human settlement; environmental management; wildlife management; traffic management as well as other public safety objectives. It has also been revealed that satellites can be used in public health initiatives such as the management of and the fight against pandemics including Covid 19 and the monitoring of government response to pandemics.

Telemedicine and consultation can also be delivered through the use of satellite technologies thus reducing face-to-face consultations between patients and health care providers. Contact tracing using various applications is also dependent on satellite technology. Moreover, satellite data can be used it can also be used to track and identify the possible transmission of various animal disease into human. The effects of climate change can also be monitored through satellites together with the provision of indications of when, where and how long human can be at risk of transmission (Zolli, 2020; Bedi, 2020; Chaturvedi, 2020).

Figure 8.3 describes the partnership model to be applied for the enhancement of border security through the application of space technology in South Africa. It depicts the relevant collaborators and the role of each party to the partnership. It further shows the primary and secondary uses of the technological solutions achieved through the envisaged partnerships. It should be noted from this figure that the role of the private space technology companies would mainly be on research and development, innovation, manufacturing, and financing. The private partner might also be required to carry substantial risk associated with the project and depending on the level of risk carried by the private partner, the private partner might claim patent rights associated with the development of products related to the project.

In addition, SAPS could use the same technologies intended for border security for its rural safety and policing activities. Considering the issue of rural safety, the researcher holds a strong view that rural safety should not be separated from border security

management. Therefore, collective efforts are necessary to address rural safety challenges, and not only farming-related safety and security concerns, but also all rural safety challenges faced by a variety of communities situated in remote areas near South Africa's borders.

The government, on the other hand, would be responsible for creating an enabling environment; defining regulatory frameworks that would give effect to the partnership; and provide some level of funding towards the project. Other private, public and non-profit organisations could also be involved in research, and development and innovation. Border security authorities, other government departments, and private interest would be responsible for determining their space technological needs, the utilisation of the assets, and where necessary, the maintenance of the said assets depending on contractual agreements.

A potential inhibitor of utilising UAVs for border security in South Africa, as noted earlier in this research, was the issue of stringent CAA regulation. PPPs, in this instance, would provide the opportunity to private UAV and UAS companies to shape government policy on the regulation of UAVs. PPPs would enable a platform that could address issues related to the drone industry in South Africa, such as addressing drone security and privacy risks; improving communications with various government jurisdictions; and evaluating operational concepts related to the safe integration of drones.

The ability of the proposed technologies to be used for multiple purposes and by multiple government departments should also receive consideration. For example, UAVs and satellites could be used for other government programmes, such as environmental management and human settlement planning. UAVs, which have been dedicated for border security, could still be used for search and rescue missions by local authorities, such as provincial governments and municipalities. The management of traffic near designated border posts could also be enhanced by utilising the same border security assets through collaborations between provincial and municipal traffic authorities and local border security authorities.

The shared use of hi-tech assets, as identified in this research, by these authorities would enable them to monitor the flow of traffic into designated border posts effectively and efficiently. Traffic authorities would then be able to monitor the build-up of traffic and initiate reactive measures to remedy the situation. For example, the build-up of traffic and resultant congestion experienced during the 2020 festive season in border areas, such as Beitbridge and Lebombo, could have been identified on time and managed with the use of space technologies, such as satellites and UAVs.

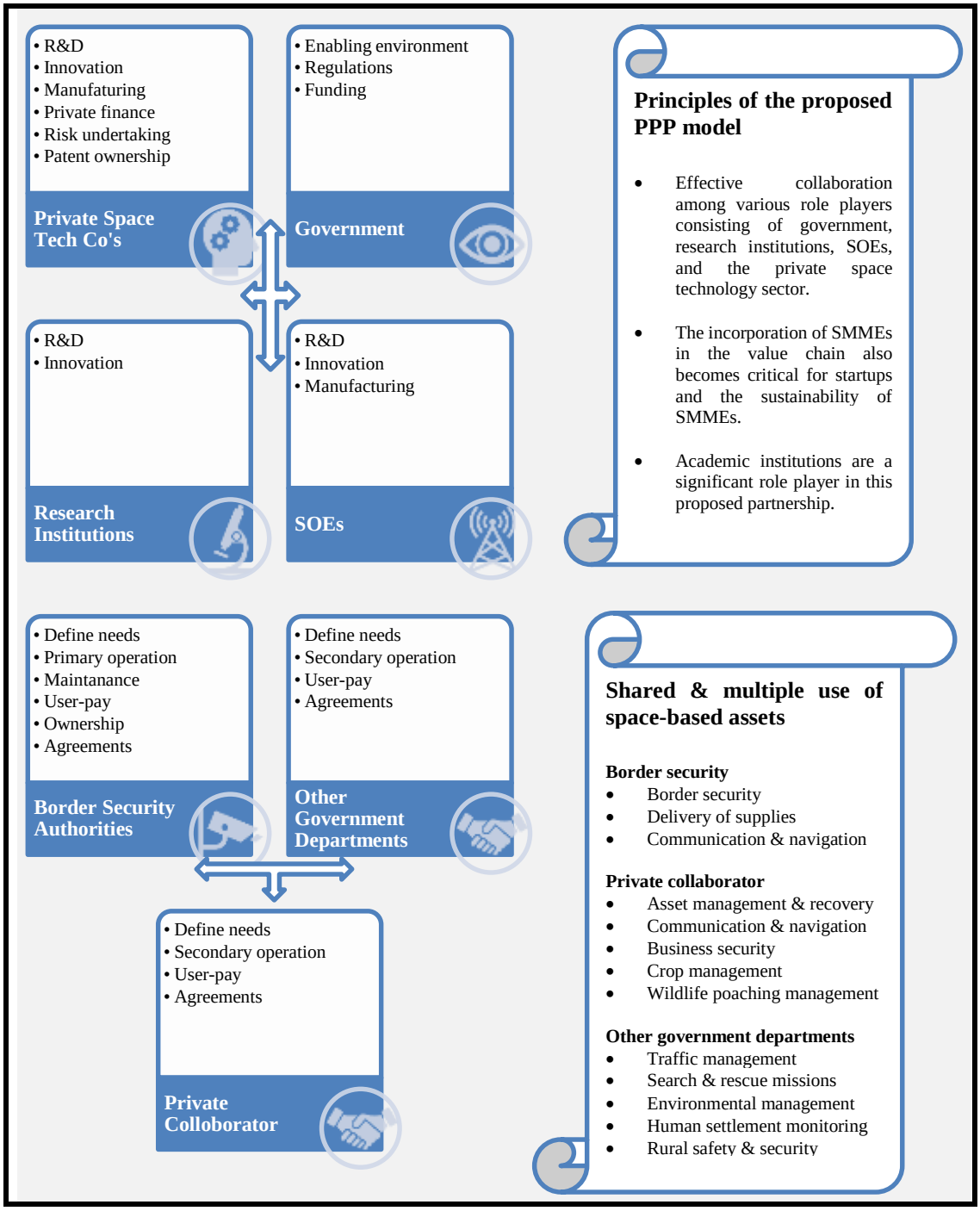
National parks and private game reserves situated near South Africa's borders could also collaborate with border security authorities and the private space technology for the shared utilisation of border security resources. Wildlife poaching and smuggling is said to be rife in national parks situated near the South African border, such as the KNP, as discussed earlier in this research. Therefore, collaboration between the national parks and private nature reserves could curb wildlife poaching and smuggling.

Moreover, as per the findings of this research, commercial farming entities near the South African borders continue to experience significant incidents of stock theft and property related crimes. As such, they could also benefit from the envisaged partnerships. It is anticipated that the envisaged partnerships will not be without challenges, as identified in this research. Factors such as corruption, conflicts of interest, lengthy and discouraging government processes, and a lack of funds were mentioned as some of the possible inhibitors of effective partnerships. These aspects would require commitment from the government, the easing of red tape, and the development of governance mechanisms intended to minimise the identified risks associated with PPPs.

Given all the above, the multitude of role players in the border environment and the impact illegal cross-border activities have on their various interests clearly suggest the need for collaborative efforts to deal with cross-border criminal activities and to enhance the levels of border security in South Africa. The ability of the private space technology sector to design and develop solution-driven technologies and their willingness to collaborate with the government, as mentioned earlier in this research, provides valuable opportunities for effective partnerships between the private space

technology sector, SOEs, SMEs, research organisations, all levels of government with an interest in border security and other activities at or near the borders of South Africa, and other private interests affected by cross-border criminal activities.

Figure 8.3: The proposed PPP model for border security in South Africa



Source: Researcher's own illustration

8.5 Conclusion

The signing of the BMA Bill into law by the President of the Republic of South Africa in 2020 paved the way for the establishment of the BMA, which will oversee border security management in the country. This will address the challenges of poor border security management and coordination in South Africa and will further ensure the streamlining of border security activities. However, it will not address the challenges associated with the approaches to border security consisting of strategy, socio-technical aspects, and the operational and tactical issues of border security. Therefore, the success of the BMA or border security authorities in South Africa will largely be dependent on the utilisation of effective border security technology, as identified in this research. This is against the background that current conventional methods of border control and monitoring have not been effective in addressing the threats and risks of border security in South Africa.

There is a need to employ effective border security technologies consisting of satellites, UAVs and other hi-tech assets, as identified in this research, to enhance border security in South Africa. It has also been established in this research that the proposed technologies could be used for multiple purposes and across a multitude of actors in government and the private sector. Thus, the adoption of space technologies would result in other added benefits, apart from their primary use in border security. It should also be acknowledged that even though governments play a central role in the provision of border security, this process should not be regarded only as a government problem. It requires effective partnerships between the public and private sectors. Against this background, border security challenges in South Africa have a negative impact on the private sector, especially in rural farming and hospitality communities and industries situated at or near the South African border.

Cross-border criminal activities also affect asset management companies who experience significant losses due to cross-border criminal activities, such as vehicle theft and smuggling and the smuggling of goods stolen from hijacked trucks. Hence, partnerships are necessary in both the development and application of suitable space technologies for border security in South Africa and for other secondary security and

related purposes. The envisaged partnerships could encourage a culture of research and development; boost technological innovation; create an enabling environment for private space technology companies to be innovative and enhance their market development; and perhaps, enable the growth of Small and Medium Enterprises (SMEs). It could also result in financial benefits and a competitive advantage for the private sector. Border security authorities could also benefit from this partnership through the utilisation of high-end technologies, which ultimately will enhance border security in South Africa. Similarly, other government department and private entities could also benefit from the secondary use of technologies derived from the partnership. SOEs could benefit from this collaboration, together with other non-profit and research organisations, who could be direct or indirect partners to the envisaged partnerships.

8.6 Recommendations

This section of the research presents recommendations based on the findings of the different chapters of this study. The researcher is of a view that the adoption of space technology for border security by border security authorities in South Africa would significantly address the challenges of border security as identified in this research and ultimately reduce the extent of border security threats and risks as identified in this research. However, certain milestones must be met, and obstacles must be overcome before this could be realised. Therefore, the following recommendations are advanced by this research:

8.6.1 Effective border security strategy

An effective border security strategy needs to be developed to give effect to border security activities in South Africa. It should be aligned to the broader national security strategy. The border security strategy should determine the operational control of the border security function; the deterrence strategy; the risk management strategy; and should be intelligence driven. The strategy should also provide for the sourcing of the various socio-technical aspects of border security consisting of infrastructure, technology and personnel.

8.6.2 Modernisation of the border security function

The border security function in South Africa should be technology driven. Thus, technology should become an important feature of the South Africa border security strategy. The monitoring and control of South Africa's vast land borders require the adoption and utilisation of technological innovations such as satellites, UAVS, radars, cameras and sensors.

8.6.3 Integrated border security systems

The effective integration of various technological solutions and other border security assets should be an important feature of border security in South Africa. This will ensure the optimal utilisation of all available border security resources through the interoperability of systems. The sharing of information among various border security unit is highly dependent on the effectiveness of transmission systems; therefore, the integration of various systems of data gathering, surveillance and communication, surveillance becomes an important aspect of border security. The human element of border security should also remain a critical component of border security.

8.6.4 Continuous technological upgrades

Technology evolves. Similarly, threats and risks to borders security also evolve and transitional criminal elements will always alter their methods of operating to avoid detection and interception. Therefore, the continuous revitalisation of technological solutions in line with global technological trends becomes necessary. Technology should be able to adapt to the ever-changing threats and risk to border security and should always be able to meet the required needs of border security authorities.

8.6.5 Training and development

Border security officials should be able to utilise all the resources at their disposal. It would serve no purpose if hi-tech assets were made available to border security authorities but could not be used due to the lack of operating skills. Therefore, the introduction of technology should be accompanied by the corresponding training of

border security officials. Border security authorities should also prioritise the capacity building of border guards in line with technological developments and the introduction of technology in the border security management environment.

8.6.6 Collective approach to border security

Border security is a component of the entire national security programme. Additionally, cross-border criminal activities do not only affect the South African government but also have a negative impact of the commercial setting situated near the South African borders. These activities also have an impact on other commercial entities affected by transnational criminal activities, as identified in this research. Given this, there is a need for effective collaboration between the state, commerce, and the community. This collaboration becomes important in combating cross-border criminal activities, consequently improving the level of border security and rural safety. There is also a need to improve bilateral cooperation with neighbouring countries for effective border security.

8.6.7 PPPs for border security technology development and acquisition

Private companies are often leaders in research and development and technological innovation. They also have the necessary financial resources to deliver on commercially viable projects. Private companies also require being involved in projects that would result in the identification and development of new market segments of their existing products. Thus, it become important to adopt effective collaborations between the public and private sectors for the purpose of developing technological assets that would be beneficial for border security in South Africa.

On the other hand, the government experiences significant pressure to deliver on public infrastructure and services. One such service, which has been a problem for South Africa, is the delivery of effective border security. Research and development institutions also seek opportunities to be involved in projects that would enable them to expand their research and development capabilities. Therefore, PPPs should be embraced to enhance border security through the application of space technology in South Africa.

8.6.8 Introduce incentives for private sector collaboration

In order to attract the private sector to participate in the development of effective border security technologies, the government should introduce incentives that encourage the participation of private companies. Such incentives, as briefly highlighted in this research, could include the participation of the private space industry in the formulation of a regulatory framework for the space technology industry. The government should also show political will regarding the development of the space technology industry, more especially the UAS industry. Other incentives could include recognition for timely and qualitative performance.

8.6.9 Minimise government red tapes

An obstacle of effective partnerships identified in this research was lengthy government processes and the lack of political will to collaborate with the private sector. Considering this, it is recommended that government should remove red tape and processes, which hindered effective collaboration between the public and private sectors. The creation of longer-term technology development agreements might also encourage the participation of the private space technology sector.

8.6.10 Encourage the participation of SMMEs

SMMEs have been recognised as critical role players in the development of a country's economy. They provide various goods and services and further create employment opportunities. With the high employment rate in South Africa and the critical need to deliver goods and services, the South African government should introduce an incentive-based policy, which would make it mandatory for private parties in a PPP to utilise SMMEs during the various phases of the project. The policy should clearly state the minimum requirement for SMME participation in various PPP projects. This would be beneficial to many satellites and UAS technologies SMMEs.

8.6.11 Continuous research and development

There should be continuous research and development of border security technologies for primary application in the border security environment in South Africa with the possibility of further utilisation in other areas of society. This should be driven by government research institutions, the academic community, non-profit organisations and the commercial space technology sector. Moreover, research, development and innovation should be government funded and capitalised by the private sector.

The research findings revealed that space technology should be utilised to enhance border security in South Africa. The research also found the need to utilise PPPs for the development and manufacturing of suitable space technologies for utilisation in border security and rural safety initiatives in South Africa. Therefore, the South African government should recognise PPPs as a vehicle to enhance border security in the country Africa and as a tool to create economic opportunities for the private space technology sector, whilst creating jobs through the SME sector. This would require a fundamental shift in mind-set since the border security function traditionally falls within the sole ambit of the state security apparatus.

8.7 Recommendations for further research

This research only focused on the application of space technology to enhance land border security. It excluded the maritime and air borders. Moreover, it focused only on selected land border areas, deemed more problematic – the South Africa-Lesotho, South Africa-Mozambique, South Africa-Botswana, and South Africa-Zimbabwe borders. The researcher was unable to interview border security officials from the SANDF. Therefore, the views of the research participants in this research do not represent the views of the entire population in the border security fraternity. Considering this, the following recommendations are made for further research:

1) The expansion of the research to other border security areas and environments, including the South Africa-Namibia borders, and the maritime and air borders.

2) Investigate the feasibility of employing space technology for border security in South Africa.

3) Conduct a cost-benefit analysis for employing space technology for border security in South Africa.

4) Investigate issues and challenges affecting the UAS industry in South Africa.

Given the above, and notwithstanding the need to expand this research further, there is an utmost need for border security authorities to integrate various space based technologies to monitor and control South Africa's vast land borders through effective public-private partnerships. The integration of various space based technologies could be of great value in enhancing border security in South Africa. The findings in this research have relevance not only in the advancement of South Africa's national security priorities, but also make a significant contribution to the discourse around the need to adapt to the new era of innovation in technology – one that is enhancing human-machine relationships, unlocking new market opportunities, and fuelling growth across the global economy.

8.8 Chapter summary

In this chapter, the researcher presented an overview of all the previous chapters discussed in this research. Furthermore, the researcher provided a summary of the key research findings and made recommendations to address the identified challenges. Lastly, the researcher also made recommendations for further research.

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Annexure A: Rejection letter SANDF

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defence intelligence
Department:
Defence
REPUBLIC OF SOUTH AFRICA

DI/DOS/202/3/7

Telephone: (012) 315-0660
Fax: (012) 326-3246
Enquiries: Col J. van Wyk

Defence Intelligence
Private Bag X337
Pretoria
0001
June 2020

AUTHORISATION TO CONDUCT RESEARCH IN THE DEPARTMENT OF DEFENCE (DOD): MR M.T. NKHOMA

1. A receipt of a request letter dd 25 June 2020 to conduct research in the DOD with a Research Proposal attached is acknowledged.

2. Access to DOD information is granted on condition that there is adherence to inter alia Section 104 of the Defence Act (Act 42 of 2002) pertaining to protection of DOD Classified Information and the consequences of noncompliance.

3. According to the Promotion of Access to Information Act 2 of 2000, the DOD may refuse access to its records or information if the disclosure relates to Military Tactics or Strategy or Military Exercises or Operations undertaken; relating to the characteristics, capabilities, vulnerabilities, performance, potential deployment or functions of any Military Force, Unit or Personnel.

4. Furthermore, access to DOD classified information is governed by the need to know principle as stipulated and enshrined in DODI 2/99 "Disclosure of Defence Information."

5. In the light of the above-mentioned security considerations; your request to conduct research in the DOD on the topic entitled **"Exploring Public-Private Partnership for Enhancing Border Security through Space Technology in South Africa"** is therefore declined.

6. For your attention.

DIRECTOR DEPARTMENTAL SECURITY: BRIG GEN
KS/KS (Mr M.T. Nkhoma)

RESTRICTED

Annexure B: Ethics clearance letter DUT

DUT DURBAN UNIVERSITY OF TECHNOLOGY | FACULTY OF MANAGEMENT SCIENCES | RESEARCH ETHICS COMMITTEE

MANAGEMENT SCIENCES: FACULTY RESEARCH ETHICS COMMITTEE (FREC)

27 November 2019

Student Name: **Mr M T Nkhoma**
Student No: 21856728

Dear Mr M T Nkhoma

DOCTOR OF PHILOSOPHY IN MANAGEMENT SCIENCES: BUSINESS ADMINISTRATION

TITLE: Exploring public-private partnerships for enhancing border security through space technology in South Africa.

Please be advised that the FREC Committee has reviewed your proposal and the following decision was made: **Approved – Ethics Level 2**

Date of FRC Approval: 27 November 2019

Approval has been granted for a period of two years from the above FRC date, after which you are required to apply for safety monitoring and annual recertification. Please use the form located at the Faculty. This form must be submitted to the FREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FREC according to the FREC SOP's.
Please note that ANY amendments in the approved proposal require the approval of the FREC as outlined in the FREC SOP's.

Yours sincerely

Prof JP Govender
Chairperson: Faculty Research Ethics Committee

South African Police Service *Suid-Afrikaanse Polisiedienste*

Privatesak Private Bag X94	Pretoria 0001	Faks No. Fax No.	(012) 393 2128

Your reference/U verwysing:

My reference/My verwysing: **3/34/2**

THE HEAD: RESEARCH
SOUTH AFRICAN POLICE SERVICE
PRETORIA
0001

Enquiries/Navrae: **Lt Col Joubert**
AC Thanga
Tel: **(012) 393 3118**
Email: **JoubertG@saps.gov.za**

Mr MTK Nkhoma
DURBAN UNIVERSITY OF TECHNOLOGY

RE: PERMISSION TO CONDUCT RESEARCH IN SAPS: EXPLORING PUBLIC-PRIVATE PARTNERSHIPS FOR ENHANCING BORDER SECURITY THROUGH SPACE TECHNOLOGY IN SOUTH AFRICA: DURBAN UNIVERSITY OF TECHNOLOGY: DOCTORATE DEGREE: RESEARCHER: MTK NKHOMA

The above subject matter refers.

You are hereby granted approval for your research study on the above mentioned topic in terms of National Instruction 1 of 2006.

Further arrangements regarding the research study may be made with the following office:

The Divisional Commissioner: Operation Response Services:

- **Contact Person:** Lt Col Geyser
- **Contact Details:** (012) 400 6367
- **Email Address :** GeyserL@saps.gov.za

Kindly adhere to paragraph 6 of our attached letter signed on the **2020-09-07** with the same above reference number.

MAJOR GENERAL
THE HEAD: RESEARCH
DR PR VUMA

DATE: 2020 -09- 2 2

1

Annexure D: Letter of information

LETTER OF INFORMATION

Title of the Research Study:

Exploring public-private sector partnerships for enhancing border security through space technology in South Africa

Principal Investigator/s/researcher:

Moses Thabo Katjisa Nkhoma, Master of Management

Supervisor/

Dr A.T. Agbenyegah, D Phil Business Administration

Brief Introduction and Purpose of the Study:

South Africa is faced with a challenge of controlling and monitoring its border. Major contributory factors to this challenge are amongst others: the vastness and porousness of the South African border; resource constraints; and poor coordination amongst border authorities. Though the emergence of space technology is being embraced by a number of countries as an alternative to the conventional methods of controlling and monitoring the border, South Africa is yet to fully adopt the use of space technology to address its border security challenges. Moreover, public-private partnerships are becoming an important feature in addressing homeland security challenges in some developed countries. This aspect is also lacking in the South African context.

The proposed study seeks to examine the feasibility of employing space technology to address border challenges in South Africa; and further seeks to examine the opportunities and challenges of forming partnerships between the public and private sector to address border security challenges in South Africa through the application of space technology. The study will be qualitative in nature and will involve the collection of data from participants involved in border

security and space technology through semi-structured interviews. The proposed study will provide practical solutions to the challenges of border security in South Africa and further contribute to the body of knowledge.

Outline of the Procedures:

- A purposive sampling strategy was followed in this study. The researcher selected individuals and site for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study.
- The autonomy to participate lies with the identified participant/s.
- The participants should have a minimum of 3 years' experience within the homeland/border security/space technology environment.
- Your participation in this study should be given freely and should be based on informed consent.
- You are not in any manner coerced to participate in this study against your will.
- You will be interviewed at a venue and time convenient to you.
- The interview will take approximately one hour.
- Your attention is further drawn to the fact that the interview will be tape recorded to ensure that valuable information elicited during the interview is captured and the context of the information can be reviewed in detail. Following the interview, the recorded material will be transcribed. You may peruse the transcription of the recording of the interview in which you participated at any time.

Risks or Discomforts to the Participant:

There are no anticipated risks or discomforts emanating from the interviews with the participants. However, the participants are required to indicate to the researcher any perceived risk or discomfort emanating from the interviews.

Benefits:

There are no financial benefits for to the participants for participating in the study. Nonetheless, the study may be published as a thesis or part thereof in a journal.

Reason/s why the Participant May Be Withdrawn from the Study:

You may withdraw from the interview at any time without any penalty. Therefore, you are participating in the study voluntarily until such time as you request otherwise.

Remuneration:

Participants will not be remunerated for taking part in the study.

Costs of the Study:

Participants will not be required to cover any costs towards to the study.

Confidentiality:

The opinions of the research participants are viewed as strictly confidential and only members of the research team will have access to the information. No data published in the thesis and journals will contain any information through which participant's may be identified. Your anonymity is therefore ensured. Moreover, the researcher will first identify the confidentiality and data security obligations, based on laws, regulations, policies of the respective institutions, and binding commitments such as data use agreements and participant consent agreements.

In addition to the measure above, the researcher will:

- Back up all data and storing backups in a location separate from the original;
- Only use the data on his personal computer; and
- Protect his computer and electronic media related to the data "sign-on" passwords.

Research-related Injury:

There are no anticipated research related injuries. The interviews will be conducted at a venue most convenient to the research participants.

Persons to Contact in the Event of Any Problems or Queries:

Please contact the researcher (Mr Thabo Nkhoma, [redacted], mnkhoma@hotmail.co.za), my supervisor (Dr A.T. Agbenyegah, [redacted], albertA@dut.ac.za) or the Institutional Research Ethics administrator on 031 373 2900. Complaints can be reported to the DVC: RIE, Prof S Moyo at dvcrie@dut.ac.za

General:

Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population e.g. isiZulu.

Annexure E: Informed consent

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, **Moses Thabo Katjisa Nkhoma** , about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____ _____ _____ _____

Full Name of Participant **Date** **Time** **Signature/Right Thumbprint**

I, **Moses Thabo Katjisa Nkhoma** herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Moses Thabo Nkhoma 28/06/2019

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**
_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**
_____	_____	_____
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Please note the following:

Research details must be provided in a clear, simple and culturally appropriate manner and prospective participants should be helped to arrive at an informed decision by use of appropriate language (grade 10 level - use Flesch Reading Ease Scores on Microsoft Word), selecting of a non-threatening environment for interaction and the availability of peer counseling (Department of Health, 2004)

If the potential participant is unable to read/illiterate, then a right thumb print is required and an impartial witness, who is literate and knows the participant e.g. parent, sibling, friend, pastor, etc. should verify in writing, duly signed that informed verbal consent was obtained (Department of Health, 2004).

If anyone makes a mistake completing this document e.g. wrong date or spelling mistake a new document has to be completed. The incomplete original document has to be kept in the participant file and not thrown away and copies thereof must be issued to the participant.

Annexure F-1: Interview guide: border security experts

Interview Schedule

Topic: Exploring public-private partnerships for enhancing border security through space technology in South Africa

1.1 What is border security? .....
1.2 What are the most prevalent border security threats and risks in South Africa? .....
1.3 In your view what are the challenges of controlling and monitoring the borderline? .....
1.4 What is your understanding of space technology? .....
1.5 In your view, can space technology be employed to enhance border security in South Africa? .....
1.6 What do you think would be the most appropriate space-based technology to be employed to enhance border security in South Africa? .....
1.7 Do you think there could be partnerships between the private space technology sector and border security authorities in developing space-based technology for improving the delivery of border security in South Africa? .....
1.8 What could be the most suitable type of the envisaged public-private partnerships? .....
1.9 What would be the opportunities of such a partnership? .....
1.10 Are there any foreseeable challenges of forming the envisaged partnerships? .....

Annexure F-2: Interview guide: UAV specialists

Interview Schedule

Topic: Exploring public-private partnerships for enhancing border security through space technology in South Africa

Section 1
1. Unmanned Aerial Vehicles
1.1 My you kindly describe what an Unmanned Aerial Vehicle is? .....
1.2 In your opinion, do you think UAVs can be used for border security in South Africa? .....
1.3 If yes to the above, what role can UAVs play in the border security environment in South Africa? .....
1.4 In your view what are the factors that may inhibit the effectiveness of UAVs to enhance border security in South Africa? .....
Section 2
2. Partnership between the public and private sectors to enhance border security through the application of space technology in South Africa
2.1 What is your understanding of public-private partnerships? .....
2.2 Considering the role of the private sector in technology innovation, do you think there is a need for public-private partnerships or any form of partnership to enhance border security through the application of UAVs in South Africa? .....
2.3 What would be the role of each partner in the public-private partnership? .....

2.4 What would be the advantages of forming public-private partnerships to enhance border security through the application of UAVs? .....
2.5 What are the possible challenges of forming public-private partnerships for enhancing border security through UAVs in South Africa? .....

Annexure F-3: Interview guide: satellites specialists

Interview Schedule

Topic: Exploring public-private partnerships for enhancing border security through space technology in South Africa

Section 1
1. Satellite
1.1 May you kindly explain what a satellite is? .....
1.2 In your opinion, do you think satellites can be used for border security in South Africa? .....
13 If yes to the above, may you kindly explain what type of satellites may be used for border security and why? .....
1.4 In your view what are the factors that may inhibit the effectiveness of satellites to enhance border security in South Africa? .....
Section 2
2. Partnership between the public and private sectors to enhance border security through the application of space technology in South Africa
2.1 What is your understanding of public-private partnerships? .....
2.2 Considering the role of the private sector in technology innovation, do you think there could be a need for public-private partnerships or any form of partnership to enhance border security through the use of satellites in South Africa? .....
2.3 What would be the role of each partner in the public-private partnership? .....

2.4 What would be the advantages of forming public-private partnerships to enhance border security through the use of satellites? .....
2.5 What are the possible challenges of forming public-private partnerships for enhancing border security through satellites in South Africa? .....

Annexure F-4: Interview guide: border security officials

Interview Schedule

Topic: Exploring public-private partnerships for enhancing border security through space technology in South Africa

1.3 What is border security .....
1.4 What are the most prevalent border security threats and risks in your area of operation? .....
1.5 In your view what are the challenges of controlling and monitoring the borderline? .....
1.4 What is your understanding of space technology? .....
1.6 What do you think would be the most appropriate space-based technology to be employed to enhance border security in your area of operation? .....
1.7 Do you think there could be partnerships between the private space technology sector and border security authorities in developing space-based technology for improving the delivery of border security in South Africa? .....
1.8 What could be the most suitable type of the envisaged public-private partnerships? .....
1.9 What would be the opportunities of such a partnership? .....
1.10 Are there any foreseeable challenges of forming the envisaged partnerships? .....

Annexure G: Turnitin report

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Thabo Nkhoma
Assignment title:	Research 2021
Submission title:	Exploring public-private partnership...
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File size:	2.27M
Page count:	381
Word count:	118,481
Character count:	659,984
Submission date:	27-Jan-2021 08:19AM (UTC+0200)
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ABSTRACT

Exploring public-private partnerships for enhancing border security through space technology in South Africa

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