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Towards understanding geographic information competencies: The case of decision-making in environmental impact assessments in South Africa

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In partial fulfilment of the requirements for the degree of Doctor of Philosophy (Geography) in the Faculty of Humanities, University of Pretoria, January **2022.**

Declaration

I Sibusisiwe Bongiwe Patience Hlela declare that the thesis, which I hereby submit for the degree PhD Geography at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

S B P Hlela
January 2022

Ethics statement

The author, whose name appears on the title page of this thesis has obtained, for the research in this work, the applicable research ethics approval. The author declares that she has observed the ethical standards required in terms of the University of Pretoria's Code of ethics for researchers and the policy guidelines for responsible research.

Abstract

Title:	Towards understanding geographic information competencies: The case of decision-making in environmental impact assessments in South Africa
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Concerns have been raised about the competent use of geographic information for decision-making in environmental impact assessments (EIAs). However, such competencies have not been categorised, nor have they been assessed before. Effectiveness studies on the quality of environmental assessments have also not been undertaken on the geographic information competencies for review of the EIA report submitted for decision making. This is a poorly researched topic on the boundaries of EIA and geographic information systems (GIS) and therefore worthy of research.

This study describes and categorises the geographic information competencies required for reviewing EIAs. As a first step, literature was reviewed to understand the use and value of geographic information for environmental management, as well as related work on geographic information competencies, competency management, and the use of taxonomies to categorise or classify information.

Next, surveys and semi-structured interviews, based on a taxonomy of the use of geographic information, were conducted with officials who review EIAs from all the provincial environmental departments across South Africa as well as the national environmental department. Analysis of the responses confirmed the invaluable contribution of geographic information in decision-making for EIA. EIA officials understood the importance of geographic information competencies. However, optimal use has been affected by a number of factors such as a lack of access to up-to-date geographic information required for the reviews, the costs of associated resources, and that some EIA officials lack technical expertise in GIS.

These results informed the development of another taxonomy for geographic information competencies. It categorises and structures competencies into different domains of competence: geography, environmental science, GIS software knowledge, field work expertise, critical thinking, and related courses. The description of competencies in the taxonomy was based on the EIA review work as specified by the participants, and its structure was guided by the literature. The element of subjectivity in the taxonomy approach was countered through the rigorous application of a mixed-methods approach. It is recommended that the taxonomy guides capacity-building efforts to facilitate optimal use of geographic information for decision-making in environmental impact assessment.

This thesis has contributed by categorising and assessing the geographic information competencies required in EIA reviews. The results of this research can guide curriculum development, even beyond the borders of South Africa. As geospatial information technologies evolve in future, there will be a need to reassess and possibly revise the taxonomy.

Key words: environmental impact assessment, EIA, effectiveness, geographic information, GIS, competence, taxonomy.

Isifingqo

Isihloko: Maqondana nokuqondisisa amakhono olwazi lwezezwe: Isehlo sokuthatha izinqumo ekuphatheni ezendalo eNingizimu Afrika

Igama lesitshudeni: Sibusisiwe Bongiwe Patience Hlela, Umnyango WeZezwe (i-*Geography*), Ezesayensi Lobuchwephese Bezezwe (i-*Geoinformatics*) kanye Neziphathelene Nesimo Sezulu (i-*Meteorology*), eNyuvesi yasePitoli, eNingizimu Afrika

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Isigaba: Isigaba SeZobuntu

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Ukunaka kuye kwaphakanyiswa maqondana nokusetshenziswa ngokwekhono kolwazi lwezezwe ukuthatha izinqumo ekuphatheni ezendalo, ikakhulukazi maqondana nokuhlola amandla okuthelela ezendalo (ama-*environmental impact assessments* (ama-*EIA*)). Kodwa, amakhono anje akakaze abekwe ngezinhlobo zawo, futhi akakaze ahlolwe ngaphambilini. Izingcwaningo eziphathelene nempumelelo yezinga lokuhlola ezendalo nazo azikenziwa maqondana namakhono olwazi lwezezwe ukuze zibuyekezwe umbiko we-EIA ongenisiwe ukuze kuthathwe izinqumo ngawo. Lesi yisihloko esicwaningwe kabi kakhulu kumingcele ye-EIA kanye ne-GIS ngakho-ke kufanele ukuthi sicwaningwe.

Lolu cwaningo luchaza luphinde lubeke ngezinhloboulwazi lwamakhono ezezwe adingekayo ukubuyekeza ama-*EIA*. Njengesinyathelo sokuqala, izincwadi ziye zabuyekezwa ukuqondisisa ukusetshenziswa kanye nokuba yigugu kolwazi lwezezwe lokuphatha ezendalo, kanye nemibhalo ehambisana nalo ephathelene namakhono ezolwazi lwezwe, ikhono lokuphatha, kanye nokusetshenziswa kwamasayensi okuhlela asetshenziswa ukuze abeke ngezinhlobo noma ahlele ulwazi.

Okulandelayo okwenziwa, yizinhlolo kanye nokuxoxisana okwakhiwe ngokungaphelele, okwesekwe kumasayensi okuhlela asebenzisa ulwazi lwezezwe, wona enziwa ngochwepheshe bokuhlola ezendalo babuyekeza ama-*EIA* eminyangweni ehlukene ebandakanyeka ekuphatheni ezendalo ukuzungeleza iNingizimu Afrika yonke. Ukuhlaziywa kwezimpendulo kuqinisekisa umbekelelo oyigugu wolwazi (ubumqoka bolwazi) lwezezwe ekuthatheni izinqumo zokuphatha ezendalo. Ama-ofishali ayabuqondisisa ubumqoka bamakhono olwazi lwezezwe, kodwa, ukusetshenziswa ngokugcwele kuthelelwa yizici eziningana, ezifana nokungakwazi ukufinyelela kulwazi lwezezwe olufakelwe imininingwane emisha edingekayo

ukuze kubuyekezwe, izindleko zemithombo ehlobene nako, kanye nokuthi amanye ama-ofishali awanabo ubuciko bezobuchwepheshe bezinhlelo zolwazi bezezwe (ama-*geographical information systems* (ama-*GIS*).

Le miphumela inikeza ulwazi lokuthuthukiswa kwelinye isayensi lokuhlela, leli eliphathelene namakhono olwazi lwezezwe. Ibeka ngezinhlobo iphinde yenze izakhiwo zamakhono ezihlukaniswe ngengqikithi yekhono: lezezwe, lesayensi yezendalo, lolwazi lokokwenza okulula lwe-*GIS*, lobuciko bokwazi ukusebenza ngaphandle emadlelweni, lokucabanga okuhlolisisayo kanye nelohide lwezifundo oluhlobene nalo. Incazelo yamakhono kwisayensi yokuhlela yesekelwa wumsebenzi wokubuyekezwa kwe-*EIA* njengoba ucaciswe ngababambiqhaza, futhi isakhiwo sawo siholwa yizincwadi ezifundiwe. Umsuka wokuzicabangela wesu lesayensi yokuhlela kubhekanwa nayo ngokusebenzisa isu lezindlela ezixubile elinzima. Kuphakanyiswa ukuthi isayensi lokuhlela lihole imizamo yokwakha amandla okwenza ukufinyelela ukusetshenziswa ngokugcwele kolwazi lwezezwe ukuthatha izinqumo ekuphathweni kwezenhlalo.

Le desetheshini inikeza ulwazi ngokwakhiwa kwezinhlobo kanye nokuhlolwa kwamakhono adingekayo uma kubuyekezwa ama-EIA. Imiphumela yocwaningo ingahola ukuthuthukiswa kohlelo lwezifundo, ukwedlulela nangale kwemingcele yezwe. Ngenkathi ulwazi lobuchwepheshe besikhala sezezwe busombuluka esikhathini esizayo, kuzokuba nesidingo sokuthi mhlawumbe kuphinde kuhlolwe bese kubuyekezwe isayensi lokuhlela.

Amagama asemqoka: ukuhlolwa kwamandla okuthelela ezendalo, i-*EIA*, impumelelo, ukuphathwa kwezendalo, ulwazi lwezezwe, i-GIS, ikhono, isayensi lokuhlela.

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Abbreviations and Acronyms

BAR	Basic Assessment Report
BSP	Biodiversity Sector Plan
CA	Competent Authority
CBA	Critical Biodiversity Authority
CHV	Coastal Heritage Viewer
CPP	Coastal Public Property
DARDLEA	Department of Agriculture, Rural Development, Land & Environmental Affairs
DDT	Dichlorodiphenyltrichloroethane
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DFFE	Department of Forestry, Fisheries and the Environment
DENC	Department of Environment and Nature Conservation
DEDEAT	Eastern Cape Department of Economic Development, Environmental Affairs and Tourism
DEDECT	Department of Economic Development, Environment, Conservation, and Tourism
DESTEA	Department of Economic, Small Business Development Tourism and Environmental Affairs
DG	Director-General
DoE	Department of Environment
DPME	Department of Planning, Monitoring and Evaluation
EA	Environmental Authorisations
EAP	Environmental Assessment Practitioner[1]
EAPASA	Environmental Assessment Practitioners Association of South Africa

[1] Please note that while EAP is often used to mean an "environmental action plan" or an "environmental assessment programme", throughout this dissertation I have followed the legislation (South Africa, 1998:8) and the standard practice in my employer, the Department of Forestry, Fisheries and the Environment (DFFE, 2019), of using EAP to mean "Environmental Assessment Practitioner."

EIA	Environmental Impact Assessment
ECA	Environment Conservation Act
EDTEA	Department of Economic Development, Tourism and Environmental Affairs
EIS	Environmental Impact Statements
EMF	Environmental management frameworks
EMI	Environmental Management Inspectors
EMPr	Environmental Management Programmes
ESPON	European Spatial Planning Observation Network
ESRI	Environmental Systems Research Institute
EU	European Union
FGDC	Federal Geographic Data Committee
FONSI	Finding of No Significant Impact
GDARD	Department of Agriculture and Rural Development
GEOSS	Global Earth Observation System of Systems
GI-N2K	Geographic Information – Need to Know
GISc	Geographic Information Science
GIS	Geographic Information System
GISSA	Geo-information Society of South Africa
GIS&T BoK	Geographical Information Science and Technology Body of Knowledge
GPS	Global Positioning System
HWM	High Water Mark
HOD	Head of Department
IEEE	Institute of Electrical and Electronics Engineering
IEM	Integrated Environmental Management
IT	Information Technology
ICT	Information and Communication Technology
INSPIRE	Infrastructure for Spatial Information
LEDET	Limpopo Department Economic Development, Environment and Tourism
LN 3	Listing Notice 3
MDG	Millennium Development Goals
NEMA	National Environmental Management Act

NEMAQA	National Environmental Management Air Quality Act
NEMBA	National Environmental Management Biodiversity Act
NEMPAA	National Environmental Management: Protected Areas Act
NEMWA	National Environmental Management Waste Act
NPC	National Planning Commission
NDP	National Development Plan
NLDO	Netherlands Defence Organisation
NSDI	National Spatial Data Infrastructure
OSM	OpenStreetMap
PLATO	the South African Council for Professional and Technical Surveyors
REDZ	Renewable Energy Development Zones
ROD	Record of Decision
RIA	Regulatory impact assessment
RSA	Republic of South Africa
SA	South Africa
SAGC	South African Geomatics Council
SANBI	South African National Biodiversity Institute
SANLC	South African National Land Cover
SAQA	South African Qualifications Authority
SASDI	South African Spatial Data Infrastructure
S&EIAR	Scoping and environmental impact assessment report
SDG	Sustainable Development Goals
SDI	Spatial Data Infrastructure
SEA	Strategic Environmental Assessments
SIM	Spatial Information Management
SPSS	Statistical Package for Social Sciences
UCGIS	University Consortium for Geographic Information Science
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNISA	University of South Africa
UP	University of Pretoria

USA	United States of America
VGI	Volunteered Geographical Information

Chapter 1: Introduction

1.1 Background

> "The decisions your organisation makes today can create a better, more sustainable world for generations to come" (ArcNews, 2019:40).

The concept of sustainable development requires all involved, the countries, organisations and individuals, to make their contributions in different ways.

South Africa's formal view on the management of the environment is expressed in the supreme law of the country, the Constitution of the Republic of South Africa of 1996. Section 24 of the Constitution focuses on environmental management and sustainable development. Environmental care and sustainable development are also prominent at an international level. Section 24 of the Constitution is about a healthy environment, free from the harm which could be caused by environmental degradation. It is also about the sustainable use of environmental resources. This requires that the current generation should use resources in a manner that takes into consideration the needs of the future generation.

This great concern about environmental management is further illustrated by the development of the principal Act with respect to environmental management in South Africa, the National Environmental Management Act (NEMA), No. 107 of 1998, as amended. This is where the concepts sustainable development and environment are defined. Sustainable development "…means the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations" (South Africa, 1998:13). This definition is essentially the same as the definition in the Brundtland Report on the work done by the World Commission on Environment and Development. In the Brundtland Report, sustainable development is defined as "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Geographic information is defined as "…information that identifies the geographic location and characteristics of natural or constructed features and boundaries on earth" (Clinton, 1994). Geographic information is one of the valuable sources of information that can be used to inform decision-making in environmental management and thus contribute to achieving sustainable development. However, the challenge revealed in the literature and from personal communications suggests that there is a lack of full use of geographic information. Some of the reasons for this low use include a lack of competence and lack of awareness of the benefits of geographic information, poor communication, lack of funds, and lack of management support and vision (Masser et al., 1996). More recently, Amade (2018:41) found that in Mozambique, "Donor pressure is the only driver that is statistically significant in both intention and adoption of geographical information technologies".

Dr R Pretorius established the geographical information system (GIS) section within what was then the Department of Environment (DoE), but now it is part of the Department of Forestry, Fisheries and the Environment (DFFE). He is now retired but was able to provide some useful insights on the use of GIS in the Department. Some of the reasons why geographic information is not used to its full potential include shortages of competent personnel in the GIS core unit, and inadequate funds (R Pretorius, personal communication, 27 September 2013).

The value of geographic information to support decision-making has been acknowledged in global events such as the 1992 Rio Summit which was assembled to discuss global issues affecting sustainable development. Geographic information was also acknowledged in the United Nations General Assembly held in 1997 to appreciate what has been done to implement the Agenda 21 (Nebert, 2004). Nebert (2004) also stated that, in 2003, the use of online digital geographic information for sustainable development was demonstrated at the World Summit on Sustainable Development in South Africa. This demonstration was considered to be a significant step and milestone achievement with respect to the use of geographic information as it happened at such a high-level international meeting.

The importance of geographic information has also been acknowledged by the introduction of the National Web-based Environmental Screening Tool in EIA regulations (DEA, 2014a). The screening tool, as it is called in the environment sector, is a geographically based web-enabled application which allows the applicants, in terms of the environmental impact assessment (EIA) legislation, to screen their proposed site or sites for any environmental sensitivity. In terms of the NEMA, 1998, as amended, environmental assessment practitioners (EAP), or EIA officials, must review the application prior to making a decision. An EAP, "…when used in NEMA Chapter 5, means the individual responsible for the planning, management, coordination or review of environmental impact assessments, strategic environmental assessments, environmental management programmes or any other appropriate environmental instruments introduced through regulations" (South Africa, 1998:8). There are different terms that can be used to refer to EIA officials. They can be called EAPs as per the legislation, or EA Practitioners reviewing EIAs or EIA reviewers or EIA officials. The term EIA regulator is also used (Cilliers et al., 2020). The common term used in the field is EIA officials. In the context of this thesis, these terms have been used interchangeably.

Effectiveness studies on environmental assessments have been carried on different aspects such as the development of a review package for assessing the quality of environmental assessments (Lee and Colley, 1992), studying factors influencing the EIA report quality (Barker and Wood, 1999), impacts of EIAs in planning and sustainable development (Jay et al., 2007), EIA report quality (Sandham and Pretorius, 2008), impact of amending EIA regulations in EIA report quality (Sandham et al., 2013), EIA systems and the importance of context (Marara, 2011; Runhaar et al., 2012; Arts et al., 2012; Zhang et al., 2012; Pope et al., 2013; Lyhne et al., 2015), specialist studies (Hildebrandt et al., 2014), assessing the quality of biodiversity (Hallatt et al., 2015), and systems effectiveness focusing on institutions and the importance of the skills of EIA authorities (Aung et al., 2020).

The International Study of the Effectiveness of Environmental Assessment stated that despite many methodological and administrative improvements, there is a need for measures to improve review of environmental assessment reports amongst other key areas (Sadler, 1996:iv). Effectiveness studies have called for more research on environmental assessment. Sandham and Retief (2016) stated that inasmuch as there have been a number of effectiveness studies, there is still a need for more research, particularly in the form of dissertations. There are some areas on effectiveness which have not been investigated. Barker and Wood (1999) identified the experience of competent authorities as one of the factors influencing the quality of EIA reports. Sandham et al. (2013) urged more practitioners who are interested to improve the quality of EIA to focus on issues other than legislative amendments. There is a need to improve other aspects of EIA effectiveness like the training and accreditation of practitioners, particularly in South Africa (Sandham at al., 2013). Fischer and Noble (2015) stated that inasmuch as several doctoral theses and academic papers have been published on impact assessment, there is still a need for more research focusing on problems faced by practitioners in the field, amongst other issues. There is a need for multi-disciplinary research, empirical studies at a PhD level as well as at international and national scale (Fischer and Noble, 2015; Morrison-Saunders and Retief, 2015). Cilliers et al. (2020) stated there is a need for more studies on the benefits of EIA from different perspectives. Cilliers et al. (2020) focused on the benefits of EIA for EIA regulators. The current study focuses on the benefits of the use of geographic information competencies in EIA review as perceived by officials reviewing EIAs.

This thesis focuses on the importance of geographic information competencies in EIA review report submitted for decision making. Geographic information competencies have been described and assessed for geographic information science (GISc) professionals (Du Plessis and Van Niekerk, 2014; Coetzee et al., 2015) or geospatial workforce (Wallentin et al., 2015). Geography core competencies for environmental impact assessments, including map compilation and reading, aerial photo interpretation and GIS usage, have been described (Sandham & Retief, 2016). However, geographic information competencies required for reviewing EIA reports that is submitted, and on which decision is mainly based have not been described and the perceptions of EIA reviewers about these have not been studied. Dr Smit, (personal communication, 16 May 2019), one of the senior officials in the field of EIA review, confirmed that geographic information is used by some officials. It tends to be used by some enlightened officials. Sometimes officials use it if they have a controversial application to review. Therefore, it is important that geographic information competencies for EIA review are developed.

1.2 Problem statement

Coetzee et al. (2014) conducted a study to understand who the GISc community are and the type of work they perform. Coetzee et al. (2014) concluded that further investigation into the demand for GISc knowledge and skills in different sectors of South Africa is still required. There has not been a clear description of the geographic information competencies required for EIA review and decision-making, and the perceptions of South African EIA reviewers about geographic information competencies required for EIA review and decision-making have not been studied before.

1.3 Research aim

The research aim is to describe and categorise geographic information competencies required for environmental impact assessment review and decision-making, based on literature and on the perceptions and opinions of EIA officials.

The author chose to use the national department, that is, the Department of Forestry, Fisheries and the Environment (DFFE), and nine provincial environmental departments as a case study because, in terms of NEMA, these are the departments responsible for decision-making on EIA applications as prescribed in NEMA section 24C. The author is employed by the DFFE and responsible for co-ordinating and conducting training for integrated environmental instruments (IEM), especially EIAs.

The DFFE is mandated in terms of the Constitution of the Republic of South Africa, Act 108 of 1996, to develop legislation for environmental management. At the time of starting this research, the name of the national department was the Department of Environmental Affairs (DEA). Therefore, it is important to mention that in some places 'DEA' will appear. For example, when the department signed the letter of support for ethical clearance, the name of the department was DEA.

1.4 Research objectives

1. To conduct a literature review on topics that will inform the research, including the use and value of geographic information in decision-making for environmental impact assessments, related work on geographic information competencies and competence management, and the value of taxonomies to categorise and classify information;

2. To distribute a questionnaire and conduct interviews with practitioners at departments concerned with environmental management in order to assess their perceptions and opinions about the use and value of geographic information in EIA report review and decision-making and about competencies required for this;

3. To analyse and discuss the results of the responses to the questionnaire and interviews, and to recommend improvement strategies;

4. To develop a taxonomy of geographic information competencies for environmental impact assessment report review and decision-making based on the results and informed by the literature review; and

5. To draw up conclusions and make recommendations based on the results.

1.5 List of publications to date

In the two papers listed below, the first paper was published in 2016 and the second is being revised. It should be noted that the work in these papers is included in this thesis with a few changes.

1. Hlela SBP, Coetzee S & Cooper AK. 2016. *Evaluating a public sector organization for SDI readiness – The case of the South African government department*. South African Journal of Geomatics, Vol. 5(2):95-107. September 2016 http://dx.doi.org/10.4314/sajg.v5i2.1.
2. Hlela SBP, Cooper AK & Coetzee S. (Undated). *Towards a task taxonomy for geographic information in decision-making for environmental management,* in preparation.

1.6 Overview of the remaining chapters

Chapter 2: Literature Review

This chapter expands on the issues raised in Chapter 1. Chapter 2 addresses the first objective of this thesis which is to conduct a literature review on topics that will inform the research, including the use and value of geographic information in decision-making for environmental impact assessments, related work on geographic information competencies and competence management, and the value of taxonomies to categorise and classify information.

Chapter 2 explains why a taxonomy was used to develop the survey questionnaire and the guiding questions. It explains why the taxonomy approach was chosen to develop the taxonomy of geographic information competencies in Chapter 7, the key contribution of this academic work.

Finally, Chapter 2 provides the rationale for developing the taxonomy of geographic information in reviewing EIAs.

Chapter 3: Method

Since this research uses both quantitative and qualitative methods, Chapter 3 explains the rationale for using a mixed-methods research approach. Chapter 3 focuses on how the taxonomy approach has been applied to respond to the second objective which is to distribute a questionnaire and conduct semi-structured interviews with EIA officials at the provincial environmental departments and national environmental department in order to assess their perceptions and opinions about the use and value of geographic information in EIA review and decision-making, and about the competencies required for this.

It explains how the taxonomic approach was used to develop the survey questionnaire and the guiding questions for the semi-structured interviews. It also explains how the approach to taxonomy has been applied to develop the taxonomy of geographic information competencies in reviewing EIAs (Chapter 7).

This chapter shows the contribution of taxonomy in categorising information which is beneficial for data collection and data analysis. It also shows the value of common elements for taxonomy development process to guide the development of the taxonomy of geographic information competencies.

Chapter 4: Survey results

Chapter 4 addresses the second objective as presented above. The results presented in Chapter 4 provide information that was used to assess the value of geographic information as well as geographic information competencies. It also provides information that contributed to improvement strategies (Objective 3), to make conclusions and recommendations (Objective 5).

Chapter 5: Interview results

Chapter 5 also addresses the second objective. The results from EIA reviewers through semi-structured interviews contributes to the perceptions and opinions of EIA officials about the use and value of geographic information in the various stages of the EIA review process, also the first in an academic study. Like Chapter 4, it also provides the information that contributed to improvement strategies, to make conclusions and make recommendations, thus responding to Objectives 3 and 5.

Chapter 6: Discussion

The chapter addresses Objective 3. It provides a discussion and analysis of the results. It provides conclusions for each of the objectives. It also provides new ways of capacity building (Section 6.2.4) which is one of the contributions of this academic study.

Chapter 7: Taxonomy of geographic information competencies

The taxonomy of geographic information competencies in this chapter is the first to be presented in an academic study. The taxonomy approach is used to present geographic information competencies in reviewing EIAs. The taxonomic approach has assisted in structuring the list of geographic information competencies as provided by participants in words (Objective 4). The taxonomy approach has been used to achieve the aim of this thesis, which is to describe and categorise geographic information competencies required for environmental impact assessment review and decision-making, based on literature and on the perceptions and opinions of EIA officials.

Chapter 8: Conclusion

This chapter addresses the last objective. The most notable results are included in the conclusion. The conclusion also reiterates the contribution of the study in the profession. It suggests recommendations for future research work.

The annexures are fundamental in this thesis. They have been placed at the end of this thesis for ease of reference.

Chapter 2:
Literature Review

2.1 Background

The first chapter introduced the framework of environmental law in South Africa. The main purpose of Chapter 2 is to address the first objective by conducting a literature review on topics relevant to this research including the use and value of geographic information in decision making for EIAs, related work on geographic information competencies and competence management, and the value of taxonomies to categorise and classify information.

It begins by explaining the definitions of EIAs. Section 2.3 explains the history of EIAs at an international level. Then Section 2.4 explains the history of EIA nationally. History is explained at an international level and at a national level to show why it is important to understand the contribution of geographic information and geographic information competencies in environmental management. Section 2.5 shows the value of geographic information in different applications. Section 2.6 provides context to the subject of competence in the use of geographic information. Spatial data infrastructure is used to provide context. Section 2.7 explains the importance of competence in the use of geographic information in the context of spatial data infrastructure. Section 2.9 provides literature review on taxonomy as it is the method used to assess understanding of the value of geographic information in reviewing EIA reports, and to categorise and assess geographic information competencies which then addresses the aim of this research. Section 2.10 focuses on related work internationally and nationally.

2.2 Definition of environmental impact assessment

Aung et al. (2020:1) argued that an EIA is one of "…the environmental planning and management tools that can compile critical information to predict future environmental impacts in decision making process".

Kidd et al. (2018) stated that there is a view that an EIA is not a decision-making tool but rather a tool that provides decision-makers with information needed to make an informed decision. This tool gives decision-makers an opportunity to understand the implications of their decision for the environment. In other words, by the time the decision-makers make a decision they are fully aware of the consequences of the development project on the environment. Therefore, on this basis, an EIA is defined as the assessment of the effects likely to occur from a major development project having negative impacts on the environment.

Furthermore, Kidd et al. (2018:1223) stated that the core of EIA lies in the so-called "technical rational paradigm", also referred to as the "information processing model". Barlett and Kurian (1999) identified the information processing model as part of the six approaches for EIAs. These theoretical models are the symbolic politics model, the political economy model, the organisational politics model, the pluralist politics model, and the institutionalist model. The focus on the information processing model was influenced by the subject of this thesis being geographic information.

The information processing model assumes that better decision-making depends on "improved science and more information". As a result of this, "EIA is described as both an 'art' and a 'science'. EIA as a 'science' or a planning tool involves methods and techniques for assessing potential impacts of the proposed project. EIA as an 'art' or procedure for decision-making involves all those measures that are taken to do a proper environmental assessment before undertaking a decision" (Wood, 2002, as quoted by Kidd et al., (2018:1224).

In South Africa, EIA is defined as "…a systematic process of identifying, assessing and reporting environmental impacts associated with an activity and include basic assessment and S&EIR" (DEA, 2014:10).

Several authors (Doberstein, 2003; Jay et al., 2007; Arts et al., 2012; Runhaar et al., 2012; Morgan, 2012; Sandham et al., 2013; Fischer & Noble, 2015; Lindsay, 2018) have revealed that EIA provides information that needs to be taken into consideration during decision-making. Some of this information comes in the form of geographic information. Hence the research aim is to understand geographic information competencies in decision-making for environmental impact assessment with the aim of assessing those competencies required for reviewing EIAs.

2.3 History of Environmental Impact Assessment at an International Level

This section explains the concern about environmental management by selecting some of the incidents such as publications, environmental activism and international conventions before delving into legislation on EIAs. As the author is also concerned about the environment, the intention is to illustrate that there are events that have taken place globally to demonstrate care for the environment (Sandham and Retief, 2016). Robinson (1987), Barnard (1999), Barnard et al. (2003), and Aucamp (2009) revealed that the concern about the environment started centuries ago.

The concern about environment dates back from prehistoric times as many religious stipulations were formed to manage balance between human and environment (Aucamp, 2009). The Industrial Revolution in the 1770s was associated with human population growth. The growth in human population had an impact on the environment. According to Barnard (1999), concern about the impact of population growth dates back in the late 1700s. Barnard (1999) stated that in 1798 the Reverend Thomas Malthus conveyed his point of view about the danger of overpopulation using this formula: "Population has always tended to increase in a geometrical progression, whereas the means of subsistence can only increase in an arithmetical progression" (Charles (1925), as quoted by Barnard (1999:18). However, there are contradicting views to the Malthusian view (Bovill and Leopard, 2006; Thirlwell, 2008). Bovill and Leopard (2006) acknowledged high population. However, their argument was based on the fact that there are other ways of addressing it other than birth control. They argued for alternative methods such as "…education programmes (especially women's education), social development, globally unequally environmental influences and impacts, gender equality and empowerment links to reproductive health and population" (Bovill & Leopard, 2006:394). Basically, Bovill and Leopard argued for alternative methods to addressing population increase instead of birth control. Thirlwell (2008) cited other reasons for environmental problems such as social and economic factors like inflation causing high food prices and unemployment leading to social unrest (demonstrations). Inflation affects food supply, affecting mainly poor countries. In addition to that, climate change and environmental degradation affects agriculture. Again this causes more strain in poorer countries.

Environmental activism was noted when Horace Greely started a campaign in a Boston newspaper in 1853 against the felling of a 2500-year-old tree in the Yosemite National Park. According to Kovarik (2007), as quoted by Aucamp (2009), this was the first printed record of environmental activism.

According to Aucamp (2009), publications that have increased environmental awareness include the book *Silent Spring* by Rachel Carson in 1962. This book exposed the hazards of the pesticide Dichlorodiphenyltrichloroethane (DDT). Another publication was *The tragedy of the commons* by Garret Hardin in 1968 (Aucamp, 2009). It stated that population growth is not a technical issue, meaning it does not require technical solutions. However, it needs to be approached or dealt with from a moral perspective (Hardin, 1968). Robinson et al. (1987) also noted that *The tragedy of the commons* led to the development of the National Environmental Policy Act (NEPA) in 1969. This increased awareness led governments to develop environmentally related laws in different parts of the world to manage activities in environment (Robinson et al., 1987).

The concern about the environment and the increased need to protect it was also noted in the 1960s (Fuggle & Rabie, 1992; Kidd, 2018). This concern was expressed through various means. What led to this concern were the negative impacts of development projects on the environment. Prior to the 1960s, greater emphasis was placed on economic development. Growth in the economy is important. However, in terms of environmental management, development as well as the associated economic growth should not lead to the destruction of the environment.

The integrated approach towards environment basically emphasises the need to assess the proposed development activity by assessing the economic impact, social impact as well as the impact on the environment instead of focusing only on one aspect (Handl, 2012).

In 1969 the United States of America (USA) moved towards an integrated approach to environmental management through the passing of NEPA. Other high-income countries such as Canada and Australia followed the USA approach. Then developing countries also followed the integrated approach. Colombia followed in 1974 and the Philippines through a presidential decree in 1978 (Lee & George, 2013).

In an attempt to protect the environment various laws were passed, but they were fragmented in nature. These laws were made to protect the environment by focusing on issues such as the pollution of air, land and water, noxious weeds, nature reserves and wildlife (Fuggle & Rabie, 1992). Then in the 1970s there was a shift from fragmented pieces of legislation to a more integrated approach with respect to environmental management. The move towards an integrated approach was seen through the passing of environmental laws with an integrated approach as well as the holding of the United Nations Conference on Human Environment, at Stockholm, Sweden, in 1972 at an international level.

The sustainable development concept came about in 1987 following the Brundlandt report which led to the international growth of sustainability and environmental assessments (Morrison-Saunders & Retief, 2012). The first Earth Summit, United Nations Conference on Environment and Development was held in Rio de Janeiro in 1992. Ten years later another Earth Summit was held in Johannesburg, South Africa in 2002. Morrison-Saunders and Retief (2012:4) are of the view that Principle 17 of the Rio Declaration on Environment and Development gave impetus to the global spread of EIA as it stated that signatory nations must employ EIA "…for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent authority".

There are various measures, or what Lawrence (1997) calls sustainability instruments, to manage the environment, as seen in Figure 2-1. The instruments include goals, strategies, legal instruments (EIA), institutional arrangements (training), leadership role by professional bodies, technology cooperation and capacity building. EIA is but one of the legal instruments that has the potential to contribute to sustainability. It is part of a suite of strategies, methods and instruments that contribute to sustainable development and environmental management, although more evidence is still needed at a practical level (Lawrence, 1997; Cashmore et al., 2004; Pope et al., 2013).

Analytical strategic environmental assessment
Biodiversity assessments
Climate change assessments
Cumulative impact assessment
Environmental management frameworks (EMFs)
Strategic environmental assessments (SEAs)
Environmental impact assessments (EIAs)
Environmental management programmes (EMPrs)
Environmental risk assessments
Environmental feasibility assessments
Norms or standards
Spatial development tools
Territorial impact assessment
Vulnerability assessment
Waste impact assessment

Figure 2-1: List of sustainability instruments

Source: *Adapted from Lawrence (1997)*

Although more than 40 types of environmental assessments have been identified, the most well-known form is project-level environmental impact assessment (Morrison-Saunders et al., 2014). Morgan (2012:7) added more impact assessment types such as regulatory impact assessment (RIA), human rights impact, cultural impact assessment, post-disaster impact assessment and climate assessment. Despite the increased growth of other types of environmental assessments, EIA is still the most established for environmental assessment worldwide (Morgan, 2012).

Morrison-Saunders et al. (2014) warned against the escalation of the types of assessments stating that it was taking EIA away from the purpose of being a sustainability tool. This view was also supported by Pope et al. (2013), noting that specialisation in the field of impact assessment is growing. However, there is also confusion with respect to the purpose of the different forms of assessment instruments. The primary contribution of EIA is likely to be in the provision of site-specific data.

EIA provides or should provide ecological, social and economic information (Lawrence, 1997). Some of this information is provided in the form of geographic information. Hence the current research focused on geographic information competencies in EIA report review.

Hunter (2007), as quoted by Kidd (2018), has provided four different ways in which EIAs are recognised in international law, as depicted in Table 2-1.

Table 2-1: Recognition of EIA in International Law

Issue	International Law	Sponsor
Global environmental issue	Some international instruments include the EIA requirement. For example, Article 14 of the Convention on Biological Diversity of 1992, requires parties, where appropriate, to make use of EIA for projects that are likely to have significant negative impact on the environment.	United Nations
Transboundary environmental impacts	This convention is aimed at the transboundary impacts of proposed development activities and the need to assess the environmental impacts, for example, the 1991 Espoo Convention on Environmental Impact Assessment in a Transboundary Context.	United Nations
Activities of international institutions	Policies of international development banks require environmental assessments for development projects such as schools, large scale farms, and medical facilities (Brazys et al., 2017), green investment projects and infrastructure projects (Gehring et al., 2018; Wang, 2017).	Development banks such as the World Bank, International Bank for Reconstruction and Development, Bank of Arab Development in Arab in Africa, etc.
National laws addressing national environmental impacts	Principle 17 of the Rio Declaration on Environment and Development at the 1992 Earth Summit provides for undertaking of EIAs.	United Nations

***Source**: Adapted from Strydom et al. (2009)*

2.4 History of Environmental Assessment in South Africa

Prior to 1997, conducting EIAs was a voluntary process and very much ad hoc. Kidd et al. (2018) summarised the four environmental assessment stages as inception (from the 1970s up to the early 1990s), formation (early to middle 1990s), formalisation (middle 1990s to middle 2000s) and refinement and sectoral expansion (from 2006 onwards).

The first environmental law that included environmental assessment was the Environment Conservation Act (ECA), Act No. 73 of 1989. This was an enabling legislation. The ECA did not make it compulsory to conduct an EIA prior to commencement of a development activity. It was only in 1997 that the first EIA regulations were promulgated.

In 1998, the principal Act in environmental management, the NEMA, Act No.107 of 1998, was enacted. The NEMA defined important environmental management concepts. Assessment has been defined as "…the process of collecting, organising, analysing, interpreting and communicating information that is relevant to decision making" (South Africa, 1998:7).

NEMA defined environment as follows:

"Environment means the surroundings within which humans exist and that are made up of-

> land, water and atmosphere of the earth;
>
> micro-organisms, plant and animal life;
>
> any part or combination of the above and the interrelationship among and between them; and
>
> the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing (South Africa, 1998:8)".

The definition of environment in South Africa covers the sustainable development concept (Kidd et al., 2018). It also includes the social, economy and ecology aspects of sustainable development.

Sandham and Retief (2016:451) pointed out that EIA is "…the most comprehensively regulated environmental management instrument in South Africa". According to Sandham and Retief (2016), EIA has been influenced by Acts such as the National Environmental Management Biodiversity Act (NEMBA), 10 of 2004, (South Africa, 2004a), the National Environmental Management Air Quality Act (NEMAQA), 34 of 2004, (South Africa, 2004b), and the National Environmental Management Waste Act (NEMWA), 59 of 2008a, (South Africa, 2008). The author adds the National Environmental Management: Protected Areas Act (NEMPAA), 53 of 2003 (South Africa, 2003) and the EIA regulations as mentioned in Table 2-2.

The move from ECA to NEMA was based on the view that ECA had a fragmented approach to environmental governance, hence the move towards integrated environmental management in Chapter 5 of NEMA.

In South Africa, the evolution of environmental management led to the amendment of NEMA in 2008 to include environmental management frameworks (EMF), SEAs, environmental management programmes (EMPr), environmental risks assessment, environmental feasibility assessment, norms and standards, spatial development tools, and any other relevant environmental management instrument (South Africa, 2008b) as part of a suite of tools to achieve sustainable development and environmental management. EIA in the suite of tools, it is the mostly commonly used environmental management instrument (DEA, 2014b).

Table 2-2: Amendments of EIA regulations

EIA regulations	Amendments
EIA regulations	1997
EIA regulations	2002
EIA regulations	2006
EIA regulations	2010
EIA regulations	2014
EIA regulations	2017

The current research focused on EIA, as this environmental management instrument has been in existence for 52 years since it was first legally introduced in 1969 in the USA. Environmental impact assessment has been adopted worldwide (Li, 2008; Marara, 2011; Arts et al., 2012; Morgan, 2012; Zhang et al., 2012; Sandham et al., 2013; Bond 2020). This emphasises the rationale for this research to focus on EIA review, hence the need to assess understanding of geographic information competencies in decision-making for EIAs.

The concept of sustainable development in NEMA is well captured in the Constitution of the Republic of South Africa, (1996) and in NEMA, as already explained in Chapter 1. However, there is a debate about the contribution of EIA to sustainable development (Morrison-Saunders and Retief, 2012; Bond et al., 2020; Cilliers et al., 2020). Bond et al. (2020) pointed out that there is a lack of evidence of the benefits of EIAs. EIA regulators are of the view that EIAs have a potential to contribute to sustainable development. However, this is currently not the case. EIA provides other "…short-term benefits such as protection of local biodiversity, public participation, legal compliance and enforcement" (Cilliers et al., 2020: 365). According to the EIA regulators, EIA does not contribute to other important benefits, such as dealing with trade-offs, the realisation of cooperative governance and giving effect to policy and planning" (Cilliers et al., 2020:365). All these benefits are important to achieve sustainable development. As Cilliers et al. (2020:365) put it, these are "…prerequisites for the promotion of sustainable development".

In South Africa, EIA is a sustainability instrument from the legal framework perspective. The Constitution and NEMA embrace the concept of sustainability. However, from the implementation point of view, there is not enough evidence that EIA contributes to the aspirations of sustainable development (Morrison-Saunders & Retief, 2012). Morrison-

Saunders and Retief (2012) suggested that in order to achieve EIA effectiveness there is a need to focus on other measures rather than continuously changing or improving the environmental legislation. Morrison-Saunders and Retief (2012:39) averred a more “pragmatic approach” by focusing on what EA practitioners can do in order to contribute to EIA effectiveness. Morrison-Saunders and Retief (2012) argued that, given the definition of EAP as provided in Chapter 1, EA practitioners, commonly known as EAPs or environmental consultants in the field, have a bigger role to play in an EIA process which can assist to deliver on the EIA mandate of sustainable development. This thesis also aligns with this view that EA practitioners have a bigger role to play, hence the need to improve the competence of EIA officials.

Since EIAs were legislated in 1997, the procedural requirements have evolved over time (Barrow, 1998). In terms of the EIA regulations of 2014, as amended, there are three listing notices. Activities in Listing Notice 1 follow the basic assessment process as shown in Figure 2-2. They are smaller in size and possibly have a less adverse impact on the environment.

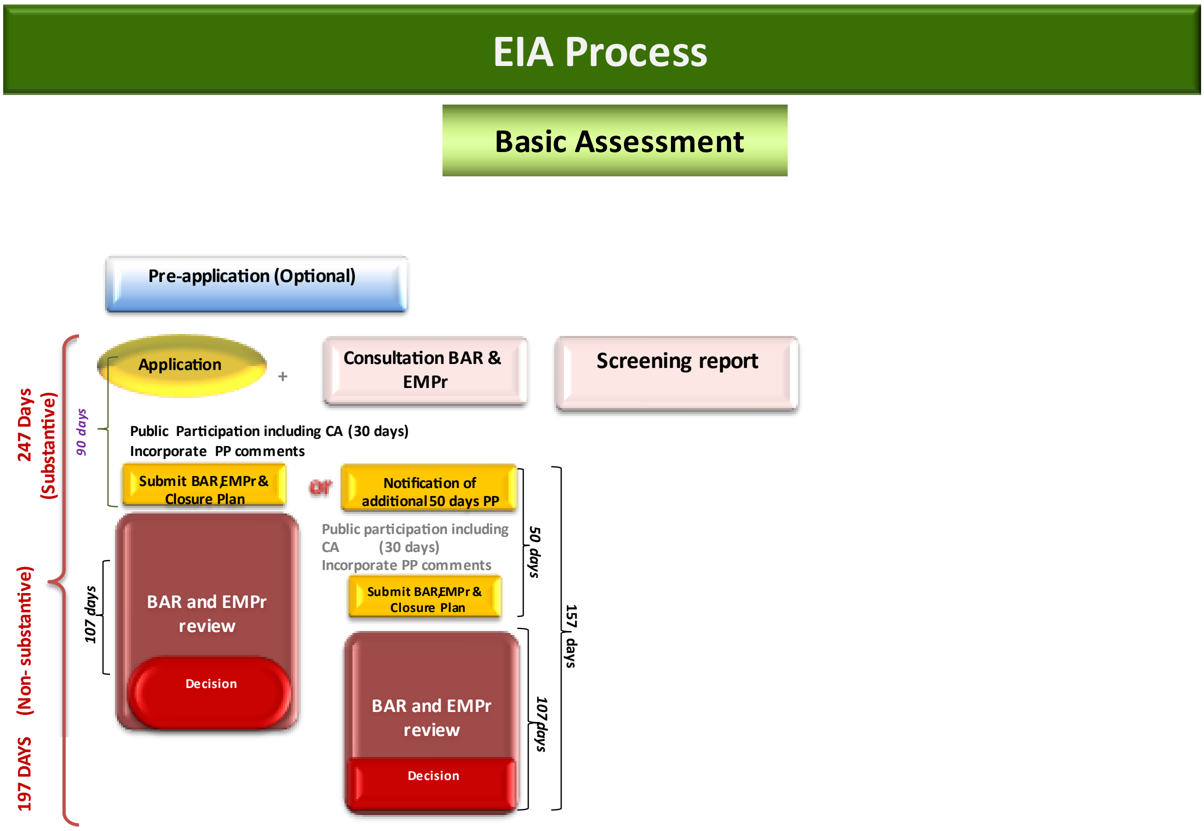


Figure 2-2: **Basic Assessment process (DFFE, 2017)**

Activities in Listing Notice 2 follow the Scoping and Environmental Impact Report as shown in Figure 2-3. They are larger and potentially have a more significant impact than those in Listing Notice 1. Listing Notice 3 contains activities in specific geographical areas. For example, the development of and related operation of facilities of aquaculture (activity 13) is listed in three specific identified geographical areas in Gauteng. These geographical areas are protected areas identified by NEMPAA, areas within a watercourse, or areas 100 meters from the edge of the watercourse. The same activity is listed in two places in the Free State, in a protected area by NEMPAA; or areas within a watercourse or wetland; or within 100 metres from the edge of the watercourse or wetland. The activities in Listing Notice 3 follow the basic assessment process as these activities are smaller than those in Listing Notice 1 as shown in Figure 2-2 (Kidd et al., 2018; South Africa, 2014).

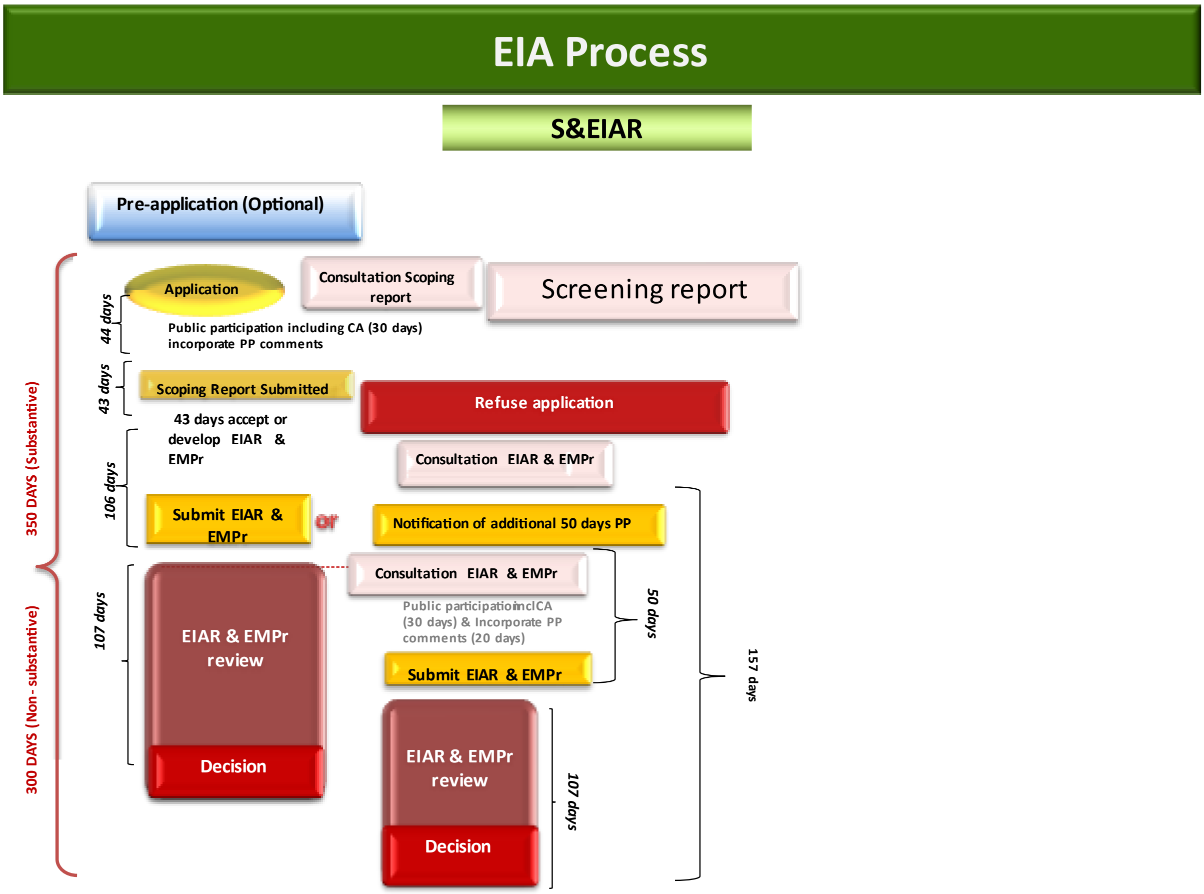


Figure 2-3: Scoping and EIAR process (DFFE, 2017)

In South Africa, as the regulations change, there is inclusion of geographical information requirements. The EIA regulations specify geographic information that the EAP (environmental consultant) must submit as part of the application, basic assessment report (BAR) and scoping and environmental impact assessment report (S&EIAR) report. The application is defined as an application for an environmental authorisation in terms of Chapter 4 of the EIA regulations. The definition for an application in the EIA regulations also includes an amendment of an environmental authorisation; amendment of an environmental management programme (EMPr); or amendment of a closure plan in terms of Chapter 5 (DEA, 2017). In terms of the EIA regulation the BAR is defined as "a report contemplated in regulation 19" (DEA, 2017:217). Then regulation 19 provides the details about submission of the BAR to the competent authority. The details about the contents of the BAR are included in Appendix 1. Scoping report means “a report as contemplated in regulation 21” (DEA, 2017:219). Regulation 19 provides information about how to submit the scoping report to the competent authority and refer to Appendix 19 with respect to the contents. The EIA report is defined as “a report contemplated in regulation 23” (DEA, 2017:218). EIA regulation 23 explains the process of submitting to the competent authorities. The details about the contents of the EIA report as well as the EMPr are contained in appendix 3 and 4, respectively (DEA, 2017).

The EIA regulations amendment of 2014 introduced the national web-based environmental screening tool (South Africa, 2014). EAPs must use the screening tool to screen their proposed site or sites for any environmental sensitivity. As the EIA evolves, the Minister has prescribed protocols in respect of specific environmental themes, such as terrestrial animal species and terrestrial plant species, for the assessment of the environmental impacts of activities requiring environmental authorisation. The EA practitioner compiling an EIA must conduct a site-sensitivity analysis using satellite imagery and any other available information. The EA practitioner must also verify the results of the site sensitivity by making use of the screening tool (DFFE, 2020).

EIA regulations 9, 10 and 16 stipulate geographic information that must be included in the application form. These requirements include compliance with protocols, minimum information requirements and a report generated by the web based environmental screening tool. EIA regulations 19 (3) and 19 (8) have similar requirements for the BAR. Then EIA regulations 21 (3) require the EAP to comply with protocols or minimum information requirements. EIA regulation 23 (3) have similar requirements for the EIA report.

In addition to the requirements above, the appendices associated with the above reports state what geographic information must be submitted as part of the report. The requirement to submit “…a map at an appropriate scale which superimposes the proposed activity and its associated structures and infrastructure on the environmental sensitivities of the preferred site indicating any areas that should be avoided” is contained in the following appendices in the EIA regulations of 2014, as amended:

Appendix 1: Basic Assessment Report (BAR) 3 (1) (l) (ii).

Appendix 3: Scope of assessment and content of EIA report (S&EIR), 3, (1) l (ii); and

Appendix 4: Content of the environmental management programme (EMPr), 1 (c)

It is important to mention that the regulations cited here are examples of the requirements. There are more regulations spelling out the requirements for geographic information to be submitted as part of the reports.

Once the report is finalised, it is submitted to the competent authority for review and decision making.

2.5 Reviewing of EIA reports

Essentially an EIA review involves a systematic appraisal of the environmental impact assessment report which contains information required for decision-making. The decision-making at a project level involves consideration of the information contained in the EIS by the relevant authority (Glasson et al., 2019).

The examples provided below about how a review is carried out in different countries demonstrate that EIA officials review information provided in the report before decision-making. Various reports such as IEEM (2006), Craik (2008), Aucamp (2009), Botswana (2011), Walmsley and Patel (2011), DEA (2014), and US EPA (2020), have revealed that the role of the reviewer involves processing information for decision making and evaluating whether the EIA report complies with the legal requirements. It has also been noted that reviewing happens at different stages of the report. In a case where the decision-maker considers the information to be insufficient to make a decision, he or she can request additional information to be provided. Finally, the competent authority must be provided with all the information necessary to make a decision.

The review methods and decision-making processes differ according to the legislation of different countries. For example, in the USA the review of an environmental assessment report involves three levels. The first one is called the categorical exclusion determination where the federal agency categorically excludes the project from an environmental review because it does not have a significant adverse effect of the environment. The second level is where the proposed action does not fall under categorical exclusion. Then the environmental assessment is prepared to determine whether there is any significant environmental impact. If the agency cannot find any significant environmental impact then a finding of no significant impact (FONSI) is prepared. In a case where the findings of the environmental assessment determines that there will be a significant environmental impact, the federal agency prepares the EIS. The EIS in summary includes scoping process, environmental impacts, public participation process and the record of decision for the decision maker (EPA, 2020).

The EIA review in Asian countries mainly involves the consideration of information from the different stages of the EIA process. The steps include a screening phase, scoping and the EIA report. As part of the EIA report, the EIA official reviews information regarding the significant impact of the project, alternatives and their associated impacts, public participation as well as mitigation measures before preparing a decision (Li, 2008).

In Swaziland, the proponent prepares the EIA report and submits it to the relevant authorities, the Ministry of Environmental Affairs or the Swaziland Environmental Authority (SEA). The relevant authority can either approve the report if it is satisfied with the information provided or refuse it. It can be refused in a case where, for example, the mitigation measures provided will not prevent harm to the environment. Then the proponent is requested to provide a revised report (Walmsley & Patel, 2011).

In Botswana, the competent authority authorises the project for implementation if it is satisfied with the information provided in the report. In a case where the information is insufficient to make a decision, the competent authority requests the applicant to provide the specific additional information required. In reviewing the application for authorisation, in terms of section 12 of Environmental Assessment Act, 2011, the competent authority considers the information provided in the terms of reference, the statement, and the recommendations of all the relevant parties (government departments, local authorities, interested persons and the public) commenting on the application before making a decision (Botswana, 2011).

In the South African legislation, the EIA official[2] must check if the application and the report, either basic assessment report (BAR) or scoping and EIR report (S&EIR) contains information in accordance with the requirements of the legislation. In terms of EIA regulation 17, the EIA official must check if the application form contains all the required information.

In terms of EIA regulation 18, the EIA official must take into consideration NEMA section 24O and Section 24 (4), the requirements of the EIA Regulations, any protocol, or minimum information requirements relevant, amongst other issues. NEMA section 24O specifies the criteria to be considered by the competent authority when reviewing an application. The criteria include taking all relevant information into account including:

"(v) any information and maps compiled in terms of section 24(3) of NEMA, including any prescribed environmental management frameworks relevant to the application" (South Africa, 1998:57).

When reviewing the BAR, the EIA official must, in terms of EIA regulation 20, either grant environmental authorisation or refuse it. The review of the BAR and making the decision must be done within 107 days (refer to Figure 2-2).

In terms of EIA regulation 22, when reviewing the Scoping report, the EIA official must within 43 days, either accept the scoping report, with or without conditions, and advise the applicant to proceed with the tasks as per the plan of study for EIA or refuse it if it does not comply with the information as stipulated in Appendix 2 or any applicable protocols or minimum information requirements.

In terms of EIA regulation 24, the competent authority must, within 107 days of receiving the EIA report and the EMPr, in writing, grant or refuse environmental authorisation.

Conducting site visits is not a prescribed requirement, however it forms part of the review process. Site visits provide the EIA reviewer with an opportunity to see the physical site of the proposed development and confirm the site information provided in the report, especially the maps of the site.

In terms of EIA regulation 26 (c), the EIA official must write the environmental authorisation and the description of the location of the activity which includes the coordinates of the property (South Africa, 2014).

[2] As much as the EIA regulations state that the competent authority must check, in the context of this study, EIA official or EIA reviewer is used, as the focus of this research is on the skills of EIA reviewer.

This section has explained the contents of the EIA reports with an emphasis on geographic information, and the role of the EIA reviewer as per the legislation. In the current research a survey was then used to gain more insight into perceptions and opinions of EIA officials about the legislation and the use of geographic information in EIA review reports. Geographic information includes both GIS and remote sensing images. The information on the use and value of geographic information has also been sourced from personal communication. Smit (2019), one of the senior officials in the field of EIA review, confirmed that sometimes geographic information is used by some officials who have knowledge of it, if they have a controversial application to review. Then geographic information is used to verify information provided in the report.

2.6 Value of geographic information

Prior to exploring competencies as a topic in this research, there is a need to explain the value of geographic information by making use of case studies where geographic information has provided invaluable information.

Geographic information is defined by different authors using many different terms. Thurston et al. (2003) have written about the plethora of terminology used for geographic information. The emphasis in Thurston et al.'s paper was not to focus so much on terms and definitions but rather to focus on the use of geographic information. This research has followed suit, the emphasis being on the use of geographic information.

Just as in other disciplines, geographical information has what Hare and Deadman (2004) called a "morass" of terms. Cooper (2016) provided different terms used for geographic information, as shown in Figure 2-4.

Some of the terms used for geographic information in different countries:

Spatial data or spatial information, spatially referenced data or spatially-referenced information, geo-spatial data, geospatial data, geo-spatial information or geospatial information, geographical data or geographical information, geographically referenced data or geographically referenced information, geo-referenced data or georeferenced information, geo-data, geodata, geo-information or geoinformation, land data or land information, cartographic data or cartographic information, map data or map information, GIS data or GIS information.

Figure 2-4: Different terms for geographic information (Cooper, 2016:30)

The definition of geographic information that has been used in this thesis is "…information that identifies the geographic location and characteristics of natural or constructed features and boundaries on earth" (Clinton, 1994). It relates to geographic features that are reviewed in the EIA activities. EIA activities include natural and man-made features. The value of geographic information in this research is illustrated by making use of real projects where geographic information has been used. One or two brief examples for each real project have been used to illustrate the point. Examples go beyond environmental management-related work in order to emphasise the breadth and depth of the value of geographic information. Real projects or applications presented here include work at an international, national and local level (refer to Sections 2.6.1 to 2.6.6).

2.6.1 Millennium Development Goals

The Millennium Development Goals (MDG) and Sustainable Development Goals (SDG) are global endeavours concerning what developed and developing countries can do to address global issues such as poverty, health, education, environmental problems, climate change, water, etcetera. MDGs came in 2000 with a list of eight targets that had to be achieved by 2015 (McKracken & Phillips, 2017). It is not the focus of this research to dwell on what was not attained by 2015. The purpose here is to show how geographic information was used in reporting on MDGs.

The MDG report also gave an account of a variety of improved technologies of collecting and disseminating data and how these improved methods have assisted in gathering real-time data (UN, 2015). The MDG report gave some of the instances where geographic information was used when the Caribbean country was affected by the chikunguya virus (chick-V) from 2013 to 2014. Geographic information was utilised to support health care and develop measures to curb the spread of the virus. In Trinidad and Tobago, geographic information applications for smart phones supported the Ministry of Health in identifying the areas of infected people in 2013 and 2014. The information was used to curb any further spread of the virus (UN, 2015).

2.6.2 Sustainable Development Goals

Figure 2-5: Sustainable Development Goals (UN, 2020)

SDGs were introduced in 2016 (Battersby, 2017). There are 17 SDGs as seen in Figure 2-5, and 169 targets and indicators. They are an extension from eight MDGs with 18 targets and 48 indicators (Waage et al., 2015). Again, as has been mentioned above, the focus in this study was on the role played by geographic information in reporting. The United Nations developed the Atlas of SDGs. The Atlas shows information about 17 SDGs (Figure 2-5) using various methods such as maps, charts, and stories. It discusses trends, comparisons, and measurement issues using shared data visualisations. In some cases, where data are limited, supplementary data from other databases or published studies are used. However, one of the problems has been the lack of reliable data to compare countries.

Countries around the world have committed to achieving sustainable development goals. The problems that need to be addressed in order to achieve sustainable development are (mostly) geographic in nature. Scott and Rajabifard (2017) explain how geographic information can be collected and connected from various sources and then used to measure and monitor the 17 SDGs, and their 169 associated targets, through the global indicator framework that supports the 2030 Agenda for Sustainable Development. Figure 2-6 is an illustration of how geographic data are collected from local levels to global levels for reporting on SDGs.

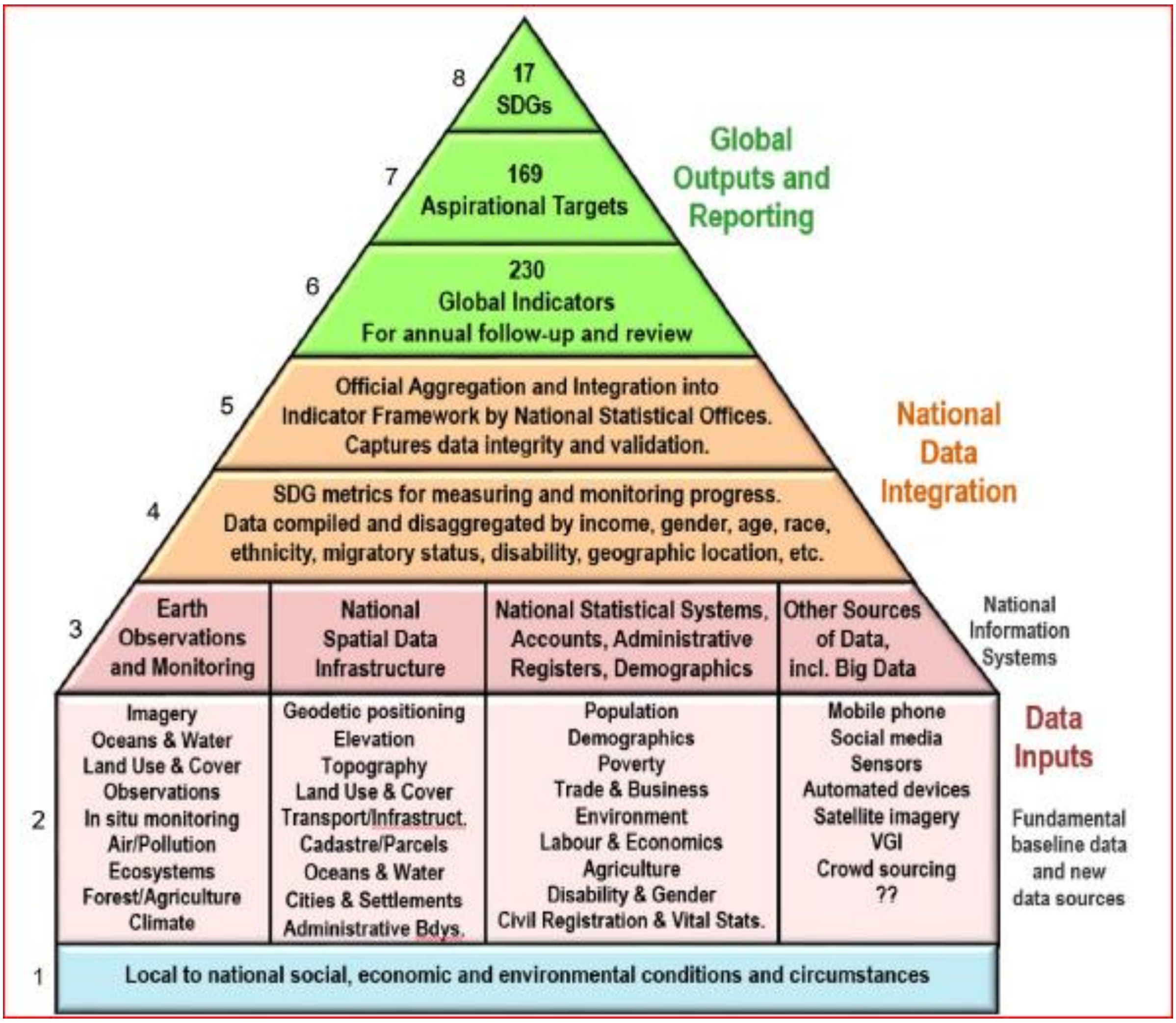


Figure 2-6: Collection of geographic information from local to global levels (Scott and Rajabifard, 2017)

2.6.3 Climate Change and Geographic Information

A number of GIS applications in climate change have been documented by organisations such as the European Spatial Planning Observation Network (ESPON), Environmental Systems Research Institute (ESRI) and Global Earth Observation System of Systems (GEOSS). ESPON's work on climate change, which includes developing a map indicating vulnerability potential to climate change in Europe, has contributed to the development of the European policy on climate change. This work does not only include comparison of data from the previous years, but also includes other projections through to year 2100 (ESPON, 2012).

Applications documented by ESRI have included climate trend analysis, creating a snapshot of biomass and carbon in US forests, assessing economic biomass resources in California, conserving Bolivia's critical resources, mapping the solar potential of rooftops in Germany, national carbon sequestration, renewable energy, and Westchester County's green map aids county global warming task force plans. To elaborate on one example to determine the amount of carbon and its location, the geographic information used in the US project covering

48 states came from high-resolution (30 metre) National Aeronautics and Space Administration (NASA) satellite datasets, topographic survey data, national land-use/land-cover data, and extensive forest inventory data collected by the US Department of Agriculture Forestry Service Forest Inventory and Analysis Program (Dangermond & Baker, 2010).

Battrick (2005) explained that the Global Earth Observation System of Systems (GEOSS) is also doing extensive work towards understanding the carbon cycle at a global scale. GEOSS aims to provide continuous climate information, which can be used for predicting, mitigating and adapting to climate variability and change, as well as better appreciation of the global carbon cycle (Battrick 2005; Lefevre et al., 2010). The GEOSS has continued to provide geographic information on climate change to make contributions on various issues such as carbon tracking for wide-ranging earth monitoring (Lefevre et al., 2010) and integrated water management (Koike et al., 2014). The GEOSS was used to integrate different types of geographic information including weather prediction models and climate change assessments to inform integrated water management projects in Asia (Koike et al., 2014).

2.6.4 Strategic Environmental Management

The Irish Coastal Heritage Viewer (CHV) is one of the classic cases showing the value of using geographic information for policymakers, planning and the decision-making process. It is a single portal for a huge range of geographic information covering coastal infrastructure, environment, heritage, marine natural resources, and planning (Longhorn et al., 2012).

The CHV was developed by using various datasets from a number of custodians. It is one of the best cases of how government, industry and citizens benefit through the use of big projects creating geodatabases (Longhorn et al., 2012).

The Irish National Heritage Council developed the CHV for eight Irish counties from 2011 (the first phase) to 2012 (the second phase). The development of the CHV assisted the Council to study and understand heritage resources of the eight counties. Therefore the CHV was used as a tool for better planning.

The value of the CHV was then tested on a series of real-life case studies which included site-specific issues, planning level and strategic levels. Just to take one example at a planning level, the Wicklow County Council realised that the CHV has provided a single portal for a huge range of geographic information. The added benefit of the portal has been efficiency on the part of the users as now they have a central repository of relevant information readily accessible. The Council noted the advantages of the map viewer for SEA development processes. It allowed users to identify environmental sensitive areas under threat as well as those areas that are important and need to be managed well. The CHV also provided better appreciation of the cross-country impact of development activities. In addition to all these benefits, the CHV provided insight into cumulative impact and commonalities between themes and conflicting areas through the overlaying of relevant thematic layers. Overall, the CHV assisted the Council to design the SEA based on a more informed analysis.

This is one of the classic cases showing the advantages of using geographic information. It shows efficiency on the part of the government. It has shown the government how helpful it is to be spatially enabled, which is the purpose this thesis. Hence, this explanation about the use of geographic information has been used based on real projects.

2.6.5 Planning at a National Level

The South African government developed the NDP 2030 in 2013 with the purpose of eliminating poverty, removing inequalities and to address numerous social challenges by 2030 (NPC, 2013). Geographic information was also used in the development of the NDP by the National Planning Commission. The diagnosis was based on the analysis of geographic information of issues such as the spatial distribution of economic activity for 2009 with respect to employment statistics in relation to the growth and decline of economic sectors, the accommodation sector, local municipalities, trade, wholesale and retail sectors, and indications of the economic viability of specific areas (NPC, 2013).

2.6.6 The Use of Geographic Information in Compliance and Enforcement

The Environmental Management Inspectors (EMI) within the DFFE are responsible for monitoring compliance with environmental management in terms of NEMA Chapter 7 (South Africa, 1998). Mr Jacobs is designated as the EMI Grade 2. He is employed by the DFFE. EMI grades range from 1 to 5. In terms of EMI designations, Grade 1 is the most senior and Grade 5 is the most junior level (DEAT, 2006). He provided the example of how geographic information is used in compliance and enforcement work. The case he provided was a matter involving an alleged illegal fence that was erected within the Coastal Public Property (CPP) with the reference: An alleged unlawful fence, Benguela Cove (S Jacobs, personal communication, 31 March 2021).

Geographic information was used to determine the geographic location of the High-Water Mark (HWM) over a number of years within the Bot river estuary. It was also used to determine whether the estuary mouth was closed. The geographic information in the form of a map also assisted the official to see the structures developed in relation to the erf boundaries.

2.7 Contextual Background

This section explains the contextual background to illustrate why it is important for officials to be competent in the use of geographic information and the whole subject of geographic information competence. The focus is on SDI developments[3]. The National Development Plan has stated that external drivers of change influence changes in an organisation (NPC, 2013). External drivers could be developments at an international level and at a national level.

To explain the value of SDI in relation to the use of geographic information, this section uses some of the information from the research of Hlela et al. (2016) in their journal paper titled *'Evaluating a public sector organization for SDI readiness – The case of the South African government department'*, with a few changes, as mentioned in Section 1.5. The information

[3] There are SDI initiatives globally (Hjelmager, 2008; Okuku et al., 2014; Coetzee and Wolf-Piggott, 2015)

has been taken from Section 2.1 of the journal paper as it is relevant to the first objective of conducting a literature review on subjects that would inform the current research, including the value of geographic information in EIAs. This section first explains the purpose of SDI, definitions of SDI, and the developments at an international level and national level[4]. The rationale behind this section is to show why it is important for officials to understand SDI-related topics.

2.7.1 Spatial Data Infrastructure

SDI enables access to and sharing of geographic information within one institution and beyond (Okuku et al., 2014). The interest in geographic information globally has been the reason behind the push that led to various SDI initiatives being undertaken at local levels and up to international levels (Hjelmager et al., 2008).

The idea of having access and sharing of geographic information on a large scale came up in the 1980s (Groot and McLaughlin, 2000; Rajabifard et al., 2002). The US National Research Council came up with the term 'spatial data infrastructure' in 1993 (Council and Committee, 1993). The SDI concept is broad and includes different types of geographic information (Hjelmager, 2008).

The concept of SDI is comprehensive and it changes over time. As a result, it has been defined in different ways (Hjelmager, 2008; Harvey et al., 2012; Hendriks et al., 2012; Okuku et al., 2014; Coetzee & Wolff-Piggott, 2015). Okuku et al. (2014) and Harvey et al. (2012) explained SDI from the viewpoint of SDI's objectives, focusing on the point of providing access to and sharing of geographic information beyond the confines of one country. The SDI initiatives worldwide have emerged as a result of the growing necessity to share geographic information beyond the boundaries of one organisation or country (Hjelmager et al., 2008). SDIs are multi-faceted in nature and transformational (Okuku et al., 2014; Hjelmager et al., 2008). Detailed work to define or to provide various definitions of SDI has been conducted. Some definitions describe it from a component viewpoint and others from an SDI objective viewpoint (Hendriks et al., 2012). The realisation of the importance of SDI has also been noticed through increased SDI publications focusing on various issues such as SDI initiatives at global level and local levels, and centralised and decentralised structures (Coetzee & Wolf-Piggott, 2015). This shows the complex nature of SDI. It also shows the depth and breadth of SDI as it has the ability to provide access and sharing within and beyond one organisation.

SDI definitions are also included to show the need for officials to understand SDI-related matters. The SDI definitions reveal the benefits of SDI.

2.7.1.1 SDI definition from a component viewpoint

McLaughlin and Nichols (1994) argued that SDI should have different components such as spatial data sources, databases and metadata, data networks and technology, policies and standards, institutional arrangements, and end-users, while Craglia and Campagna (2009) said

[4] SDI initiatives in Africa (Makanga and Smit 2010). SDI initiatives worldwide (Rajabifard et al 2003; Grus, 2007)

that SDI consists of networks of people and institutions where technology and data provide support.

SDI involves strategies, technology, infrastructure, and standards to conform to. SDI capacitates people. SDI has a capacity building outreach. There are university courses and courses at tertiary institutions and there is a professional body to register people who study geographic information science (R Pretorius, personal communication, March 2016).

2.7.1.2 **SDI definition from an objective viewpoint**

SDI is basically an infrastructure for accessing and sharing spatial data to reduce the duplication of spatial data collected by users and producers and enable better utilisation of spatial data and associated services (Grus et al., 2010). Spatial data infrastructure helps facilitate access to and effective use of geospatial data for decision making applications (Makanga & Smit, 2010).

In this thesis, both types of definitions have been considered to be important because they show the comprehensive nature of SDIs. They include a variety of components, people and institutions being most important in the context of this thesis. Objective viewpoints are also important because they show the purpose of SDI. These definitions make it clear that the whole intention of establishing a SDI is to allow access and sharing of geographic information by all users. Both the component and the objective viewpoints provide an understanding of the constituent parts and abilities of spatial data infrastructure. Both viewpoints show the length and breadth of SDI in terms of what it offers.

Globally, SDI has been regarded as an “indispensable infrastructure” (Makanga & Smit, 2010:18) in terms of facilitating accessibility and sharing of geographic information. For example, the European Union (EU) geoportal provides various functionalities with the intention of making access to and sharing of geographic information easier. Functionalities such as ‘identify’, ‘discover’, ‘query’, and ‘document all relevant content including metadata’, have been improved from time to time. Geoportals provide geographic information for various applications, too many to count, but one can include agriculture, environment, transport networks, planning, health services, and many more (Maso et al., 2012; Dukaczewski et al., 2013; Tomic, 2016).

The readings cited above show that the situation has improved compared to just a decade ago. The geoportal will promote easier access to various geographic information from multiple institutions, that is, private and public organisations (Bernard et al., 2005).

Another example is OpenStreetMap (OSM) founded by Steve Coast in London in August 2004 (Haklay, 2010). The aim of OSM is to create a free digital map by allowing different willing contributors to provide volunteered geographic information (VGI). OSM GeoStack allows users to “…capture, produce, communicate, aggregate, and consume the geographical information produced in the project” (Haklay & Weber, 2008:14). The information that is collected by multiple participants (Haklay & Weber, 2008; Haklay, 2010; Quinn, 2017) is then collated into a central database and then distributed through the world wide web. The advantage with OSM is that it allows people with little knowledge about mapping to contribute to online geographic information (Haklay & Weber, 2008). OSM also allows for the editing of geographic information by registered users. As much as the OSM approach is such a great way of making online geographic information freely available, users of OSM need to be aware of the problems in terms of the quantity and quality of information collected by various willing contributors (Quinn, 2017).

This realisation that SDI is such a vital infrastructure for geographic information led to the establishment of institutions and committees to manage the development and implementation of SDI initiatives. In Europe, there is Infrastructure for Spatial Information (INSPIRE) and in USA there is Federal Geographic Data Committee (FGDC). In Africa, the United Nations Economic Commission for Africa (UNESCA) is the leading institution on SDI matters (M Moodley, personal communication, 22 June 2020[5]), although the institution still needs to be strengthened on a number of areas in order to be at the level of INSPIRE (Schwabe & Govender, 2009; Guigoz et al., 2017).

Inasmuch as there are still a number of areas on which Africa needs to improve, work is happening in different countries. Organisations that are involved in collecting core base data sets have realised the importance of working together in order to reduce duplication in the collection of geographic information and to also allow for easier access to and sharing of information (Makanga & Smit, 2010). Kenya is one example where, even though progress is ad-hoc, public and private organisations continue to provide access to and sharing of geographic information in the geospatial community (Okuku et al., 2014). Atumane and Cabral (2019) explained SDI developments in Mozambique, also confirming that organisations continue to produce thematic datasets which form the core of Mozambican SDI.

In South Africa, the leading organisation on SDI matters is the South African Spatial Data Infrastructure (SASDI). SASDI was established in terms of Section 3 of the South African Spatial Data Infrastructure Act No. 54 of 2003, as a "…national technical, institutional and policy framework, to facilitate the capture, management, maintenance, integration, distribution and use of spatial information" (RSA, 2003). Like INSPIRE and FGDC, SASDI came about as a result of the need to manage the duplication of collection of the same data by different organisations within the same country, among other issues. This would reduce the waste of financial resources which could be used in other areas.

The overall purpose of this section was to demonstrate the importance of SDI in relation to the use of geographic information, and geographic information competencies. It has also shown the value of SDI to demonstrate why it is important for EAPs reviewing EIAs to be knowledgeable about SDI. The next section deals with definition of competencies and competence management.

[5] Moodley is the current Director of the Spatial Information Management section. She is a registered Professional GISc Practitioner.

2.8 Competencies and Competence Management

2.8.1 Definition of Competencies

The research aim is to categorise and assess geographic information competencies in reviewing EIAs.

The definition of human competence has been approached in different ways by numerous authors (Gale and Pol, 1975; McGrath Rita, 1995; Le Deist, 2005; Laakso-Manninen and Viitala, 2007; Broos, 2008; Mäkelä et al., 2010). Broos (2008) stated that competencies are a medley of attitudes, behaviour, insight, knowledge and skills, while Laakso-Manninen and Viitala (2007) said that they are about the ability of employees to execute their functions. Roe (2002), as quoted by Bartram and Roe (2005) defined competencies as a skill which one acquires over time to perform his or her duties satisfactorily.

According to Hoge et al. (2005), unlike the definitions above, competencies could consist of one or more elements. Their approach to competencies was the same as that of Roe (2002), as quoted by Bartram and Roe (2005), that it is learned over time. One learns one skill at a time or learns more skills simultaneously.

The view about the definition of competencies in this thesis supports the notion that competency is a combination of different aspects. Competencies are not made up of a single aspect, for example knowledge or practical experience only. It is made up of a suite of all of these aspects. Also, one accumulates experience over time.

The researcher also acknowledges the subtle differences in these terms, competence, competency, competences and competencies. DiBiase et al. (2010), uses the term competency to refer to a model, then uses competencies to refer to the list of skills listed in the competency model. Sandham and Retief (2016) uses competences when listing core geographic competences. Competencies is used to refer to knowledge and skills (Broos, 2008; DiBiase et al., 2010; SAQA, 2018). Du Plessis and van Niekerk (2014), also use the term competencies to refer to the knowledge and skills but also include abilities.

In this thesis, competencies is the term used to refer to knowledge and skills needed to do something. Hence the title of this thesis uses the term competencies because the focus is on the GISc knowledge and skills needed to do decision making in environmental impact assessments. Competence management is explained Section 2.8.2.

Numerous studies such as those of Hoge et al. (2005), Broos (2008), Du Plessis and Van Niekerk (2013), and Coetzee et al. (2015), to cite a few, investigating competencies or including the subject of competency (Wessels, 2013) are a significant indicator of the importance of competencies. The various definitions of competencies illustrate that competency is beyond knowledge only. It is made up of a number of elements as indicated above in the definitions. The formulation of survey questions and the guiding questions in the current study was influenced by this understanding.

Effectiveness studies (Barker and Wood, 1999; Morgan, 2012; Arts et al., 2012; Aung et a.l, 2020) on environmental assessments have also shown the need for the competencies or experience of EIA regulators to be given greater attention in order to improve the quality of EIA reports. The need for greater attention to be given to the capacity of officials has also received attention recently (DPME and DEA, 2019). According to Barker and Wood (1999), participants' experience (EIA officials in this thesis) has an impact in the quality of EIA report review. Barker and Wood (1999) identified factors influencing the quality of EIA reports from a variety of studies on EIA quality reporting.

The experience of participants which includes competent authorities, amongst the others, was found to be the single most important factor influencing the quality of EISs in the United Kingdom, Germany, Spain, Denmark, Greece, and Portugal. However, a similar finding could not be made in Ireland. EIA effectiveness studies have pointed out that capacity building needs to be given more attention to improve the quality of EIA reports (Barker & Wood, 1999; Aung et al., 2020). Aung et al. (2020) emphasised the importance of the skills of EIA authorities in the China's Belt and Road Initiative. Morgan (2012) argued that to improve the quality of EIAs, there is a need to improve the professional aspect.

Lack of training and capacity building have been cited as some of the reasons causing the weakness of the EIA report. Hence this thesis stresses the significance of the development of geographic information competencies and capacity building of EIA regulators.

2.8.2 Competence management

Laakso-Manninen and Viitala (2007:27) explained that, in the late 1980s, organisations realised that for them to have a competitive advantage, they should put more emphasis on the competence and knowledge of their employees. They defined competence management as an intervention that helps the organisation to increase its ability to perform at a competitive advantage based on competence. According to Laakso-Manninen and Viitala (2007), competence management includes all interventions that promote and develop the skills required to achieve the strategy of the organisation.

An example of competence management was the development of the Reference List of General Physician Competencies (Englander et al., 2013). The existing competency frameworks such as PubMED, Google, and web sites of selected health care organisations were used to find published competency frameworks. There was a comparison of the lists from existing work with the draft reference list. The results of the analysis led to the development of a new reference list of general physician competencies. It had eight domains and list of 58 competencies (Englander et al., 2013). The existing frameworks were used to modify the language of the draft list. The description of the reference list of general physician competencies followed the taxonomy approach. The approach for the physician competencies was found to be very useful in the development of the taxonomy in Chapter 7. The taxonomy approach influenced the design of the taxonomy in this study.

2.9 Taxonomy

The first objective is to conduct a literature review about, amongst other issues, the value of taxonomies to categorise and classify information.

This section explains the purpose and value of using taxonomy as was used to develop the survey questionnaire and the guiding questions for the semi-structured interviews. Taxonomy has also been used to develop the taxonomy of geographic information competencies in Chapter 7, which is the main contribution of this thesis.

This section provides the purpose and value of taxonomies as they have been developed and used for a very long time. Hence they are a reliable method to use. Parts of the second journal paper (refer to Section 1.5) are based on this section.

Calkins and Obermeyer (1991) realised that geographic information is critical for GIS and spatial analysis techniques development. They realised that such an investigation can be done through surveys and case studies. They then realised that a taxonomy is required to organise surveys and case studies. Calkins and Obermeyer (1991) developed a taxonomy for investigating the use of geographical information and its associated value to structure the surveys and case studies. This taxonomy is intended to support continuing research into the use and value of geographical information.

2.9.1 The Purpose and Value of using Taxonomy

2.9.1.1 The term taxonomy

Since many authors recognise the vital role of taxonomies, a number of definitions or synonyms exist. According to Sokal (1963) and Cooper (2016), 'taxonomy' is a science of classification, while Ranganathan (1951) used the term 'classification' instead of 'taxonomy'. Taxonomy has been used interchangeably with classification (Krathwohl, 1956; Bloom, 1964) with systematics (Sokal, 1963) and with typology and frameworks (Englander et al., 2013; Nickerson et al., 2013). Despite numerous definitions of taxonomy, there is still some confusion about the terminology. Out of the 73 papers surveyed by (Nickerson et al. (2013), 56 used the term 'taxonomy' and 17 use the term 'typology'. 'Taxonomy' is used interchangeably with a number of terms, and it has been argued that sometimes this is done incorrectly (Cooper, 2016).

What is common from the papers analysed is that researchers have acknowledged different definitions and then provided reasons why a particular term would be used. For example, Nickerson et al. (2010) made it clear that for classifying mobile applications the term to be used was 'taxonomy' because it "…is more common and recognisable than the term typology" (Nickerson et al., 2010:4). They also fully acknowledged that the term 'typology' may be more accurate depending on the context.

A number of taxonomists prefer the term 'taxonomy' over many other terms. Cooper (2016) used taxonomy because it is the term most closely associated with scientific classification (Cooper, 2016). The term taxonomy is used in this thesis because it is already commonly used by numerous researchers (Calkins & Obermeyer, 1991; Shneiderman, 1996; Hare & Deadman, 2004; Lee et al., 2006; Rautenbach et al., 2017; Riggs & Gordon, 2017), to cite a few.

2.9.1.2 History of taxonomy development

A review of the literature has revealed that taxonomies have been developed since time immemorial, at least several hundred years BC in Europe (Simpson, 1961; Bloom, 1979; Krathwohl, 2002) and they continue to be developed to this day (Tsolakis et al., 2014; Cooper, 2016; Rautenbach et al., 2017). Biological taxonomies are divided into pre-Linnaean and post-Linnaean and have influenced taxonomies in other fields. Manktelow (2010) gave an account of a number of taxonomists from the pre-Linnaean era up to post-Linnaean era. Simpson (1961) tracked the zoological classifications from the 17th and 18th centuries, when the eponymous Linnaean hierarchy was developed by Carl Linnaeus.

Numerical taxonomy aims at objective classification using algorithms to identify patterns or clusters in the data such as quantities or concentrations of various biological building blocks, rather than presence or absence, that represent the different taxa. There is obviously some subjectivity in selecting the algorithms and weights to use, and in the data available for the algorithms. Cytotaxonomy, using chromosomes, and chemotaxonomy, using chemical constituents, are effectively variations of numerical taxonomy. The equivalent in other fields is statistical classification.

Taxonomies can be extraordinarily complex. For example, the ninth revision of the International Statistical Classification of Diseases and Related Health Problems, also known as the International Classification of Diseases (ICD-9) has 6 969 codes and ICD-10 (introduced in 1990) has 12 420 codes, and it is not possible to convert data sets from one to the other (WHO, 2020). Yet the ICD is primarily for reporting and analysing mortality and morbidity statistics, so for reporting on diseases such as for claiming on health insurance, ICD 9 Clinical Modification (ICD 9-CM) was developed, with 14 567 allowable codes and ICD 10-CM now has 71 486 allowable codes to describe patient medical conditions (Ellis et al., 2020). Similarly, ICD-10 Procedure Coding System (ICD-10-PCS) was developed for capturing over 70 000 inpatient procedures. Moving from ICD 9-CM to ICD 10-CM for private health insurance resulted in instantaneous increases or decreases of 20 percent or more for 16 percent of diagnostic categories (Ellis et al., 2020).

Taxonomies are vital for researchers, managers, practitioners, and in curriculum development because the classification of objects produces a better understanding of the objects. Examination of complex matters by breaking them down into smaller components results in improved understanding of issues (Glass & Vessey, 1995; Cooper, 2003; Tory & Moller, 2004; Englander et al., 2013; Nickerson et al., 2013). Taxonomy studies have come from different disciplines such as medicine (Englander et al., 2013), psychology (Batram & Roe, 2005; Kaslow et al., 2008), and education (Bloom, 1979).

2.10 Related work

2.10.1 Geographic information competencies

This section explains how competencies for geographic information competencies for GISc professionals have been described and assessed. Competencies developed for geospatial-related competencies have provided lessons which were used to develop the taxonomy of geographical information competencies in Chapter 7.

It has been seen that researchers develop competencies by comparing the results of their studies with the work of other researchers, identifying similarities and differences and then providing a new list of competencies. Models developed for competencies are also revised from time to time (DiBiase et al., 2007; DiBiase et al., 2010; Du Plessis & Van Niekerk, 2014; Wallentin et al., 2015).

Competencies have been developed for various professionals such as psychologists (Bartram and Roe, 2005; Kaslow et al., 2008), medical practitioners (Englander et al., 2013), and GISc professionals (Du Plessis & Van Niekerk, 2012, 2013, 2014) to cite a few. The description of competencies for various professions illustrates the importance of developing and refining competencies continuously.

The reasons behind the development of competencies have been influenced by the concerns about competencies in a particular field. The wish is to have the "…body of knowledge that separates the profession from others and defines the relationships among its related professions"(DiBiase, 2008:1506). The concern about competencies was also seen in the development of the competencies model for geospatial professionals by NASA. Concerns about competent geospatial workers led NASA to fund the development of a competency model for geospatial professionals (Gaudet et al., 2003).

The development of a taxonomy for geographic information competencies in Chapter 7 was influenced by the same concern from the author. EIA effectiveness studies have shown the need to focus on the accreditation of practitioners and capacity building other than amending legislation (Sandham et al., 2013) to improve the quality of EIA report review.

At an international level, the example used in this section is the development of the first Geographical Information Science and Technology (GIS&T) Body of Knowledge (BoK) initiated by the University Consortium for Geographic Information Science (UCGIS) in 1997. This GIS&T BoK was done by comparing the work done for computer science by the Association for Computing Machinery (ACM) in 1969 and a revision in 1978. In 1991, the ACM worked together with The Institute of Electrical and Electronics Engineering (IEEE) and produced the curricula for both computer science and computer engineering. The GIS&T BoK was then published in 2006 (DiBiase et al., 2007).

The first edition of GIS&T BoK was an ambitious work as it was done over seven years by seven editors and 70 contributors and reviewers. This US-led work included a hierarchical list of 10 knowledge areas, 73 units that included body of knowledge, 329 topics and over 1 660 education objectives (DiBiase et al., 2007).

The GIS&T BoK developed by UCGIS, which was the first model, was revised and the new Geospatial Technology Competency Model (GTCM) was developed (DiBiase et al., 2010). The GIS&T BoK has been revised from time to time (Wallentin et al., 2015). One of the main aims of the GIS&T BoK is to provide comprehensive knowledge areas known as 'body of knowledge' for geospatial professionals and it continues to support the profession to date (University Consortium for Geographic Information Science (UCGIS) (2021).

The GIS&T BoK work is respected as researchers use it as a basis for their work (Reinhardt, 2011; Du Plessis & Van Niekerk, 2013; Coetzee et al., 2015; Wallentin et al., 2015). This thesis has also used it for comparison. The difference is that this academic research describes geographic information competencies required by EAPs reviewing EIAs. The knowledge areas have significant similarities except that the content within the domains and list of competencies in Chapter 7 are related specifically to EIA report review work.

The GTCM for the geospatial technology industry developed by the Geospatial Workforce Development Center has provided another example at an international level. The GTCM incorporates competencies other than technical GISc skills (Gaudet et al., 2003). The taxonomy for geographic information competency in Chapter 7 includes technical GIS knowledge and skills. Other competencies are already included in the EAP qualification standard SAQA ID 61831 (SAQA, 2018).

In South Africa, extensive work has also been done with respect to the development of geographic information competencies for GISc professionals. The example used in this study is the GISc Framework and Competency Set for Curricula Development at South African Universities (Du Plessis & Van Niekerk, 2014).

Prior to explaining how the new GISc Competency model was developed, it is important to explain what led to the development of the new model. Du Plessis and Van Niekerk (2013) followed a similar approach as the GIS&T BoK of developing a new set of competencies by comparing it with existing work. Du Plessis and Van Niekerk (2013) conducted a qualitative and quantitative comparison of the three sets of geographical information science competency requirements, namely, the GIS&T BoK developed by the UCGIS that has been explained above, the South African Unit Standards-Based Qualifications (USBQ), and the South African Council for Professional and Technical Surveyors (PLATO) model. The findings revealed that inasmuch as the GIS&T BoK has been considered to be extensive, it does not include some of the competencies that are regarded as important by the South African GISc community. South African GISc community considers fundamental sciences and research methods as important in the GISc curricula. The European GIS community identified such shortcomings in the GIS&T BoK comprehensive work (Reinhardt, 2012).

Another finding was that a number of competencies that the US GISc community deemed as critical are not included in the USBQ and PLATO competency models. It was on this basis that a new competency model was required for the GIS industry and academia (Du Plessis & Van Niekerk, 2013). Du Plessis and Van Niekerk (2013) then developed a new framework for essential competencies by comparing them. The qualitative and quantitative comparisons of the existing work led to the identification of similarities and differences in the list of competencies. The geographic information competencies in Chapter 7 followed the same approach by comparing primary data from the survey and interviews with existing work.

While GIS&T BoK has been regarded as the extensive work, four additional knowledge areas and 15 units or competencies which are essential for the South African GISc community have been discovered (Du Plessis & Van Niekerk, 2013). This was expressed by the GISc community representatives who were participants in the study. Participants were requested to rate the competencies provided on a scale of 1 to 5. The results revealed that data modelling and geospatial data knowledge areas were rated the most important, whereas physics was rated the least important.

Du Plessis and Van Niekerk (2014) described the geographic information competencies by developing a list of fundamental, core and elective competencies within each knowledge area. Table 2-3 presents the knowledge areas and fundamental core competencies and units.

The Geo-information Society of South Africa (GISSA) survey of the South African GISc community reported the skills required by the South African GISc to perform day-to-day activities. Data acquisition, data manipulation, data modelling, cartography and visualisation, analytical methods, were high on the list. Mathematics and physics were also mentioned but they were low in the list, refer to figure 2-7 (Coetzee et al., 2014)

Table 2-3: New GISc framework for South African GISc community

FUNDAMENTAL COMPETENCIES	CORE COMPETENCIES CONTINUE
Knowledge Area GS: Geographical Science	**Knowledge Area GC: Geocomputation**
Unit GS1 Human geography	Unit GC10 Computer programming
Unit GS2 Physical geography	**Knowledge Area GD: Geospatial Data**
Unit GS3 Environmental geography	Unit GD1 Earth geometry
Knowledge Area MS: Mathematics and Statistics	Unit GD3 Georeferencing systems
Unit MS1 Mathematics	Unit GD4 Datums
Unit MS2 Spatial statistics	Unit GD5 Map projections
Knowledge Area PS: Physical Science	Unit GD6 Data quality
Unit PS1 Kinematics and Newton's laws of motion	Unit GD7 Land surveying and GPS
	Unit GD10 Aerial imaging and photogrammetry
CORE COMPETENCIES	Unit GD11 Satellite and shipboard remote sensing
Knowledge Area AM: Analytical Methods	Unit GD12 Metadata, standards, and infrastructures
Unit AM3 Geometric measures	**Knowledge Area GS: GI S&T and Society**
Unit AM4 Basic analytical operations	Unit GS6 Ethical aspects of geospatial information and technology
Unit AM5 Basic analytical methods	

Source: Du Plessis and Van Niekerk (2014:10)

Coetzee et al. (2014), Du Plessis and Van Niekerk (2014), and Wallentin et al. (2015) showed that competency models have been developed for various reasons such as to guide curriculum development, certification and accreditation, to guide training, to inform job descriptions, and to assist organisations in recruitment processes.

Prior to the development of the EAP qualification, geography core competencies were developed (Sandham and Retief, 2016). Geography core competencies include the geographic information competencies of map compilation and reading, aerial photo interpretation, and GIS usage. Again Chapter 7 extends from those listed in the geography competencies.

2.10.2 EIA Competence

The EAP qualification standard, SAQA ID 61831, has six exit-level outcomes. These are the areas of competencies that the EAP needs to demonstrate before he or she can be registered as an EAP. Each exit-level outcome has the associated assessment criteria. Exit-level outcome 5, which is to review and monitor environmental assessment procedures and methods, mentions two geographically related competencies, the geographical information system and mapping. Use of technology is mentioned under critical cross-field outcomes. Therefore the

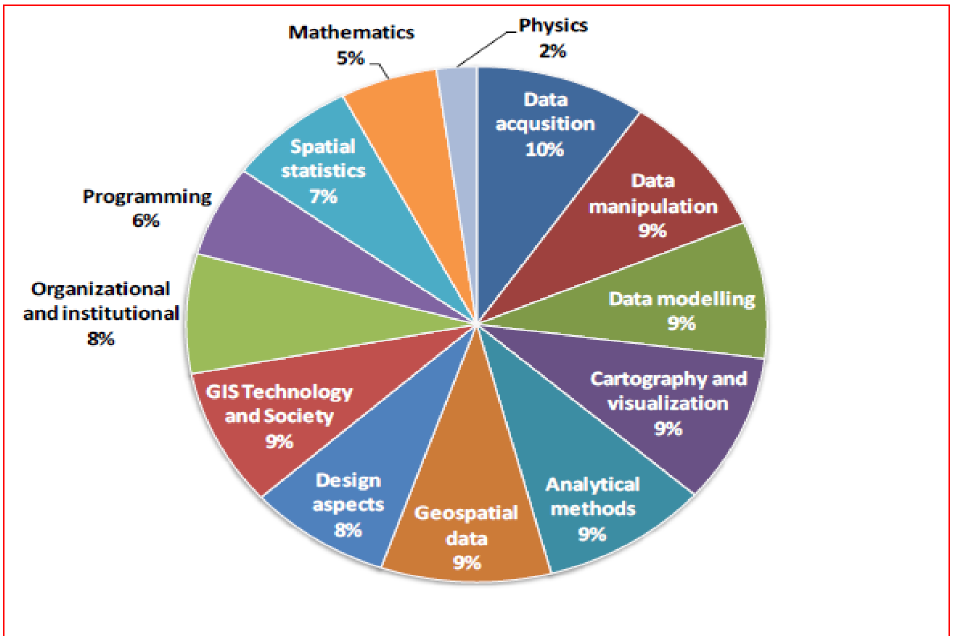


Figure 2-7: GIS knowledge and skills of GISc community (Coetzee et al., 2014)

EAP qualification has three geographical information-related competencies. The taxonomy in Chapter 7 extends the list from those mentioned in the EAP qualification (SAQA, 2018).

The job descriptions of EIA reviewers were also reviewed to verify whether geographic information competencies had been developed or not, and also whether there have been any that have been included in the job descriptions. The job descriptions reviewed came from three provinces. Since officials do similar work there was no need to request job descriptions from all the provinces. The job descriptions reviewed were for all the grades in Table 2-4. The numbers from 1 to 5 in Table 2-4 were not determined by the department. The author added them to show the ranks of EIA reviewers. Basically, these are the grades of participants in this study. No geographic information-related competencies were found in the key performance areas. Instead, only the global positioning system (GPS) was mentioned as an enabling condition, which means officials need the GPS to perform their EIA review work. This again confirms that participants require the necessary resources in EIA review work.

Table 2-4: Grades of the job descriptions reviewed

Ranks from junior to senior	Levels of EIA reviewers
1	Environmental Officer Grade A
2	Environmental Officer Grade B
3	Environmental Officer Grade C
4	Control Environmental Officer Grade A
5	Control Environmental Officer Grade B

2.10.3 Overview of GIS and GISc Education in Tertiary Institutions

This section presents a synopsis of the history of GIS and GISc education. The history of GIS and GISc education in tertiary institutions provides a context for the results of this academic study. This section also reveals some of the pertinent issues with respect to the curricula that are of relevance to this study.

Studies conducted on GIS and GISc at an international level (DiBiase, 2008; Du Plessis & Van Niekerk, 2012; Hodza et al., 2015), and at an African level (Coetzee & Eksteen, 2012) have revealed some of the issues with respect to GIS and GISc that are applicable to this research. Maswanganye (2018) focused on specific academic institutions in South Africa.

GISc was introduced to universities around the world in different decades following the introduction of GIS in the 1950s and 1960s (Calkins & Obermeyer, 1991:342). GIS is usually taught as part of geography in most academic universities (DiBiase, 2008; Du Plessis & Van Niekerk, 2012). DiBiase (2008) explained that GIS courses also vary in terms of scope and content. SDI topics have been reported. However, specific aspects of a number of the SDI topics have not yet been covered in the academic model, for example, geoportals, organisational structures and planning, the value received from geographic information, and the value chain of geographic information (DiBiase, 2008).

The GISc was introduced later (Messina & Shortridge, 2006). GISc is offered as part of certain disciplines such as geography, surveying, town planning, environmental and computer science programmes, and content varies (DiBiase, 2008; Du Plessis & Van Niekerk, 2012).The structure of GISc programmes has been influenced by various factors such as staff availability, especially experts in the field, developments in technology, legislation, requirements of professional bodies, and market demands (Hodza et al., 2015).

Vandenbroucke and Vancauwenberghe (2016) also added weight to the curriculum issues. They acknowledged the developments with respect to geographic information and technology, yet academic, public and private employers have had difficulty in finding experienced staff. However, there is a tool, Geographic Information – Need to Know (GI-N2K), that has been developed to bridge the gap between what tertiary institutions offer and the market demands. The GI-N2K tool aims to prepare GIS&T professionals for workplace. The GI-N2K project consist of partners (academic, non-academic and the industry) with the aim of improving how GIS&T professionals are trained so that their skills match the job requirements of the industry. One of the significant aims of the GI-N2K project is to update the GIS&T BoK as the geographic information changes rapidly. Updating the existing Body of Knowledge will assist in redefining the curriculum, training and ensuring that professionals are kept abreast of what is happening in the industry (www.gi-n2k.eu).

In South Africa, surveys of similar nature as the GI-N2K project have been conducted (refer to Table 2.3 and Figure 2-7 in Section 2.10.1).

Eksteen et al. (2015) conducted a study comparing GISs education in African countries and Latin American countries. The results indicated: “There is one university with GISc education for every 6 million people in Africa, and one for every 3.6 million in Latin America. The result of their study in the light of the value of geographic information, as explained in Section 2.5, showed the need for more officials who are skilled in GISc. GISc is relatively new in established academic institutions and even more so in South African Universities of Technology (Du Plessis & Van Niekerk, 2012).

The developments of academic programmes have been influenced by various issues such as legislation and professional bodies, GIS staff availability, costs associated with hardware and software, quick technological changes (Hill & Nel, 1996; Coetzee & Eksteen, 2012). Hill and Nel (1996) investigated the use of GIS in South African universities and their study shows what universities offered with respect to GIS in the 1990s.

Maswanganye (2018) observed that the inability of the undergraduate geography curriculum in South Africa to equip students with sufficient knowledge and skills has created a heavy burden on the labour market because employers are expected to retrain graduates when they commence their formal employment: “It was established that students never had an opportunity to do fieldwork using GIS” (Maswanganye, 2018:91). Du Plessis and Van Niekerk (2012), Eksteen et al. (2015), and Hodza et al. (2015) have pointed out the problems of the structure of programmes, the availability of institutions, and expertise in GISc education in Africa and internationally. Hill and Nel (1996:152) reported similar issues: “Both undergraduate and postgraduate classes at many universities are so large that access to limited computer facilities is restricted, and this can impede GIS training. Computer facilities are essential, as GIS techniques can be taught much more effectively in practicals rather than in lectures”.

Maswanganye (2018) also recommended revision of the undergraduate programmes to make sure that they prepare graduates for employment. There have been discussions around the curricula in tertiary institutions (DiBiase, 2008; Du Plessis & Van Niekerk, 2012; Coetzee et al., 2015; Vandenbroucke & Vancauwenberghe, 2016; Maswanganye, 2018). The value of the overview of GIS education has shown the significance of developing geographic information competencies as competencies guide curriculum development. Hence it has been recommended that competencies are developed and revised continuously because they are critical for curriculum development (DiBiase, 2008; Du Plessis & Van Niekerk, 2012).

Table 2-5 shows recent developments with respect to the universities and the list of qualifications recognised by the South African Geomatics Council (SAGC, 2021).

Table 2-5: Universities and the list of GISc qualifications

University	Qualification
University of Cape Town	B.Sc Geomatics
Universiteit Stellenbosch University	B.Sc (Hons) Geoinformatics
University of Pretoria	B.Sc Geoinformatics
	B.Sc. (Hons) Geoinformatics
Cape Peninsula University of Technology	National Diploma Cartography (GISc)
Esri South Africa	Diploma in Geoinformation Science and Technology

The differences in terms of content in the various GISc programmes have provided insight with respect to the results of this study (DiBiase, 2008; Du Plessis & Van Niekerk, 2012; Du Plessis & Van Niekerk, 2013; Hodza et al., 2015; Maswanganye, 2018).

2.11 Conclusion

The aim of the thesis is to describe and categorise geographic information competencies required for EIA review and decision-making. This chapter has reviewed the use and value of geographic information in decision-making for environmental impact assessments, the related work on geographic information competencies and competence management, and the value of taxonomies to categorise and classify information.

This chapter has concentrated on explaining the significance of geographic information in EIA. This led to the subject of competence and competence management to illustrate why officials reviewing EIAs need to be competent in the use of geographic information by focusing on the SDI context. This chapter closed by explaining what has been done with respect to the development of competencies in other professions and then focusing more on what has been done to describe and assess geographic information competencies for the GISc community. Geographic information competencies for the geospatial workforce have been described and assessed extensively.

Chapter 3 explains how taxonomy was applied to assess the use or the value of geographic information in EIA review. It also explains how the taxonomic approach was applied to assess the understanding of geographic information competencies.

Chapter 3: Method

3.1 Introduction

The aim of this research is to describe and categorise geographic information competencies required for environmental impact assessment report review and decision-making, based on the literature review and on the perceptions and opinions of EIA officials. The first objective for achieving the aim of this thesis was dealt with in Chapter 2. The second objective, is to distribute a questionnaire and conduct interviews with practitioners at the national department (DFFE) and nine provincial environmental departments to assess their perceptions and opinions about the use and value of geographic information in EIA report review and decision-making and about competencies required for this. Both quantitative and qualitative approaches have been used to address this second objective. Section 3.3.1 provides the rationale for using mixed-methods approach in this research.

This chapter addresses this second objective by explaining how the taxonomy approach was used in the survey and semi-structured interviews to assess understanding of the value of geographic information. Section 3.4 explains how the taxonomy approach informed the survey and semi-structured interviews. Section 3.5 provides details about the development of the taxonomy of geographic information competencies in Chapter 7.

Sections 3.6 explains the factors that influenced the use of mixed method approach in this research. Section 3.7 and 3.8 explain all the preparations undertaken to collect qualitative and quantitative data. Section 3.9 explains the data analysis as well as the reliability of the results. Then follows the limitations of the study in Section 3.10. The chapter ends by explaining ethical considerations in Section 3.11.

3.2 Background to the Study

Chapter 1 provided the background about environmental management, sustainable development and the environmental management tools that South Africa has put in place through legislation and institutional mechanisms. EIA is one of the environmental tools that South Africa has put in place to manage the environment. The development and the process of reviewing the EIA report has been defined in terms of the law. EIA effectiveness literature has pointed out various measures that can be investigated in order to improve the quality of the EIA report. The focus of this research is on reviewing the geographic information that is submitted as part of the EIA report. However, research has revealed that geographic information is not used at its optimal level. Yet it has been shown in the current literature review that geographic information is an invaluable tool. Details on this were provided in Section 2.6 above.

It is on this basis that the researcher decided to conduct a survey to establish an understanding of the invaluable contribution of geographic information in EIA review from the officials' perspective and also understand what it takes to use geographic information in an EIA review. She also decided to investigate what the geographic information competencies are that are required in order to review EIAs.

The review and decision-making in EIAs are done by officials all over the country. Figure 3-1 is a map of environmental affairs offices in the country. Full names of offices which appear as acronyms in the map have been included in the abbreviations and acronyms table. According to D Marais (personal communication, 24 March 2021), this is the first map of environmental affairs offices in the country. D Marais[6] is one the most senior officials and the longest serving member in the SIM Directorate. He is a registered Chief GISc Professional. He has served the department (DFFE) for 29 years.

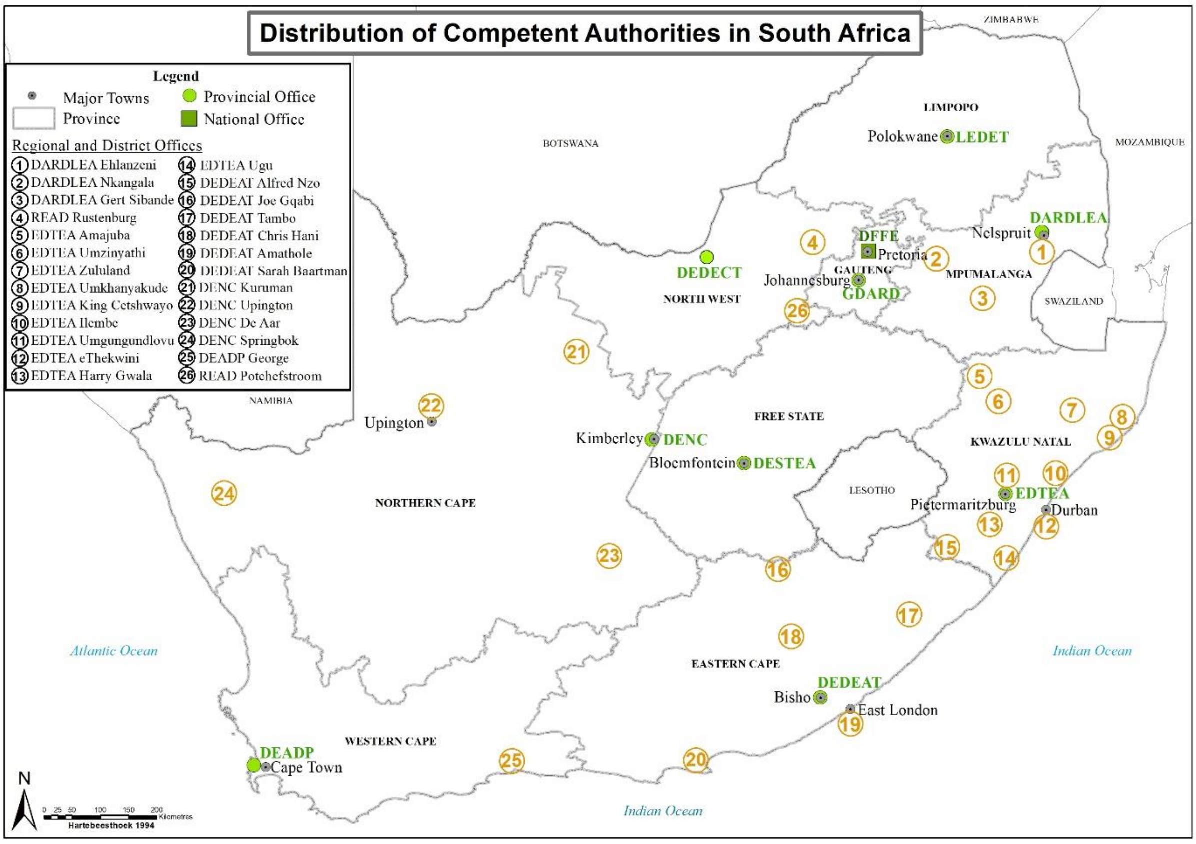


Figure 3-1: Map of Environmental Affairs offices (D Marais, 2020)

Section 24C of NEMA stipulates the procedure for identifying competent authority. It sets out when the Minister is the competent authority for activities. For example, the Minister is the competent authority for activities which have implications for international environmental commitments or relations, where the development crosses international or provincial boundaries, or if it will take place within a nationally proclaimed area. In such cases, applications are reviewed by the EIA officials in the national office. Environmental Affairs

[6] Mr Deon Marais is the compiler of the map of Environmental Affairs offices.

officials in the national or provincial office review the EIA applications using the same EIA regulations.

3.3 Research approach

3.3.1 History and Background of Mixed-Methods Research

This section explains when this research approach began, the terms used for mixed-methods research, studies done on this research paradigm as well as mentioning other studies that have applied it. The advantages of mixed methods are shown at different stages of this research as well as some of the discussions, debates and controversies around it. However, the emphasis is on the appropriateness of this research approach and its advantages in the light of the research problem.

It would not be possible to condense the rich history of this research approach as numerous methodologists have written about it. Numerous researchers from various disciplines, as they are cited in this chapter, have also applied it in their research work. This section emphasises that inasmuch as it is the third research approach, there is growing interest in it.

Mixed-methods research is called the third research approach because in terms of the history of methods it came after the quantitative approach and qualitative approach. These two approaches have been based on the work of western philosophers, Plato (quantitative) and Sophists (qualitative) (Johnson et al., 2007).

Johnson et al. (2007) noted that the research work of sociologists and anthropologists such as Jahoda, Lazarsfeld, and Zeisel, 1931/2003; Gans (1963), Lynd & Lynd, 1929/1959, Hollingshead (1949), started acknowledging the strengths of both quantitative and qualitative methods and started combing methods in their research work. The earliest research work using combined methods was that of Lynd and Lynd in 1929. As much as when it stated the term mixed-methods research was not used, the use of both techniques can be identified in every decade from the 1920s (Johnson et al., 2007).

Rossman and Wilson (1985) published an article which showed the shift from quantitative to qualitative approaches to using both methods. Rossman and Wilson (1985) reported that educational research work used to be dominated by quantitative approaches, citing the work of Cronbach and Suppes in the 1960s. Then there was a change of focus to the qualitative approach, as seen in the work of the researchers such as Rist in 1977 and Shulman in 1981.

In addition, Rossman and Wilson (1985) reported that the work of Trow in 1957, which showed that there was noticeable evidence that no single method dominated research. Instead different methods were being combined. Sieber (1973), another educational researcher, supported the use of both fieldwork (qualitative) and survey methods (quantitative). Also included in Rossman and Wilson's (1985) article was the work of Cook and Reichardt, 1979, on merging research methods in evaluation research. Smith (1983, as quoted by Rossman & Wilson, 1985) noted that the whole issue of the American behavioural scientist focused on the use of multimethod research.

Rossman and Wilson (1985) pointed out that the shift in terms of approach has not been without debates and controversies. Smith (1983, as quoted by Rossman & Wilson, 1985:628) stated that: "The debate is still ongoing, for as one observer recently noted, there are still divergent views about combining methods. Other researchers are strictly following one particular method instead of combining them."

Bryman (2006) demonstrated an interest in mixed methods according to disciplines. He identified articles in sociology, psychology, management and organisational behaviour, geography and media and cultural studies that have used mixed research. He argued that these articles have provided an indication of an interest in mixed research.

In addition to demonstrating interest by discipline, Bryman (2006) also listed countries which were in North America, the United Kingdom, Europe, Australia, the Middle East, and Asia, based on the affiliation of the authors. Countries in Africa and Latin America were noted as the lowest contributors at the time of writing of his article.

In 2010, Teddlie and Tashakkori (2010) published their second edition of the SAGE *Handbook of Mixed Methods in Social and Behavioural Research*. These authors noted that it was only seven years since their first publication, but a significant amount of work had been published using mixed-methods research. They identified research work published by researchers and methodologists such as Johnson and Onwuegbuzie (2004), Brannen (2005), Morgan (2007), Bergman (2008), and Morse and Niehaus (2010) (Teddlie & Tashakkori, 2010).

Teddlie and Tashakkori (2010) used the same approach as Bryman (2006) by noting interest in mixed methods according to countries. Teddlie and Tashakkori (2010) noted that research reports with mixed methods have been increasing in countries such as the US and Canada, European countries, Australia and New Zealand, and Japan. In the second handbook it was noted that there has been work published from other countries but relatively little has been done (Teddlie & Tashakkori, 2010).

According to Creswell and Creswell (2017), mixed-methods research started in the 1950s, although the term 'mixed methods' was not used. Creswell and Creswell (2017) noted that researchers were combining qualitative and quantitative research methods as early as the 1950s. The list includes, among others, Jick (1979) with his interest in converging or triangulating different quantitative and qualitative data sources, and Creswell and Clark (2007) on the development of a distinct method of inquiry.

Creswell has written extensively about mixed-methods research (Creswell, 1992; Creswell and Maietta, 2002; Creswell, 2009; Creswell, 2012; Creswell & Poth, 2016; Creswell & Creswell, 2017; Creswell & Creswell, 2018). Creswell and Creswell (2017) pointed out that there has been a growing interest in this third research approach. Hence it was also used in the current academic study. Methodologists such as Tashakkori and Teddlie (1998), Bryman (2006), and Greene (2007) have published books dedicated to mixed-methods research (Creswell & Creswell, 2017).

Journals are also giving attention to mixed-methods research. Journals writing about mixed methods include the Journal of Mixed Methods Research, Quality and Quantify and Field Methods (Creswell & Creswell, 2017).

In order to understand the geographic information competencies, it is critical to use both approaches. The qualitative approach in this research allowed interviewees to elaborate on the need for a particular geographic skill, whereas quantitative approach showed the significance of geographic information competencies by providing “robust and reliable data” (Day et al., 2008:330). Also, the quantitative approach allows descriptive statistical analysis (Creswell & Creswell, 2017). It was for this reason that both approaches were used. Therefore the use of both approaches assisted in achieving the aim of this research, that is, to describe and categorise geographic information competencies.

This section has focused on the history of mixed-methods research by showing much has been written about it. Mixed-methods research continues to grow as more and more scholars are writing about it. More researchers are applying it in their research work. This section has also shown the credibility of this approach as it is applied in research. The next section identifies terms used in mixed methods by various methodologists and researchers. It ends by explaining that, given the plethora of terms, which terms are used in the current research, and why.

3.3.2 Terms for Mixed-Methods Research

Given the history of mixed methods research, various authors such as Bryman (2006), Johnson et al. (2007), Teddlie and Tashakkori (2010), Creswell and Creswell (2017), and Creswell and Creswell (2018), to cite a few, have provided different terms for it.

In this research, the terms mixed-methods research and mixed research are used interchangeably because they are already used by numerous scholars and researchers (Bryman, 2006; Greene, 2006; Johnson et al., 2007; Yvonne-Feilzer, 2010; Creswell & Creswell, 2017; Creswell & Creswell, 2018). This clarifies which research approach was used in this research. It will also assist future researchers to use this thesis and learn about the rationale, advantages and how mixed research is applied in reality (Johnson et al., 2007).

3.4 Research design

This section explains how the taxonomy approach informed the design of the survey (Annexure 3.4) and semi-structured interviews (Annexure 3.3). It also explains how the taxonomy approach informed the development of the taxonomy of geographic information competencies in Chapter 7.

The subject of competence and the development of models for competencies thereof requires detailed understanding (refer to Section 2.8 and Section 2.10 respectively). It was for this reason that both the quantitative and the qualitative approaches were chosen to assess understanding of the value of geographic information and geographic information competencies required (objective 2).

3.4.1 Mixed Methods

The researcher needed to develop questions that responded to the aim and objectives of this research, hence the use of both approaches. The advantage of the qualitative approach is that it allows the respondents to explain their views and opinions of a particular subject from their own perspective (Creswell, 2007). However, Peshkin (2000) viewed this as subjectivity. The qualitative approach allows the researcher to describe and make connections from the data collected. In order to obtain a thorough understanding of a topic, the researcher needs to allow a discussion to flow, meaning that it allows emergent issues to be discussed (Creswell, 2007).

Since the qualitative approach has been associated with subjectivity (Peshkin, 2000), the quantitative approach allows inference, provides data quality, and allows transferability (Denzin, 2010:423). "Statistical techniques help us to investigate relationships within our world" (Walker, 2010:211). Descriptive statistics were used (Annexure 4.1) to test associations between certain questions. Both methods were used because combination of data collection methods and analysis in this study provided a greater in-depth understanding of the value of geographic information and geographic information competencies than using a single approach, (Tashakkori & Teddlie, 2003, as quoted by Day et al., 2008).

Part of the first objective was about conducting a literature review on topics that would inform the research about the values of taxonomies to categorise and classify information. The taxonomy for surveying the use and value of geographic information provided insight in terms of questions that need to be included in a survey about use of geographic information. Calkins and Obermeyer (1991) have created the list of questions which could be used in a survey about the use of geographic information. As a result, some of the questions in this survey were adopted and adapted from their survey.

The list of questions was structured into categories. This provided order and the author saw fit to use this method as it would help during the analysis. It helped the researcher to reduce time spent to create codes, categories and themes which is typical in a qualitative approach (Patton, 1999; Miles et al., 2014).

Other preparations that were done included conducting pilot interviews. Pilot interviews were conducted face to face with three officials from the national department. The pilot included officials from different ranks in the interest of getting different views. The pilot assisted a great deal in clarifying questions and checking understanding of questions by another person. It also assisted the researcher to test how to ask questions and measure the time needed. As a result, the actual questionnaire that was sent indicated how much time it might take to complete the interview. This helped in terms of allocating the time for interviews as officials are busy people.

Testing to complete the questionnaire was done with supervisors and the statistician. Qualtrics Support was consulted during this process to assist in designing and testing the questionnaire using Qualtrics.

The advantage of using surveys is that the survey through technology can reach a large number of people. However, there are also problems that were experienced. Initially, surveys were sent through Qualtrics and there were some problems in accessing Qualtrics, and some offices had limits in terms of how many emails they could access (refer to Section 3.8.3). To address this limitation, the researcher used emails as an alternative method. Several reminders were sent through emails (refer to Annexure 3.5), phone calls (both landline and cell phone), SMS and WhatsApp. According to Kim et al. (2006), Balabanis et al. (2007), and Church and De Oliveira (2013), SMS and WhatsApp are used even in academic research. As mentioned in Section 3.8.3, section managers assisted in sending the questionnaires to additional people that were not included in the initial email, and they also assisted in doing follow ups. For example, through section managers the researcher managed to find out whether a particular official was in the office or not. All the emails including reminders had the due date for a response. Sending reminders and writing due dates assisted in increasing the number of participants.

The taxonomy developed by Englander et al. (2013) (*Towards a Common Taxonomy of Competency Domains for the Health Professions and Competencies for Physicians*) provided insight into the development of the taxonomy for the current research. The list of geographic information competencies from the current research was qualitatively and quantitatively compared with the existing work on competencies, EAP qualification, job description of EIA reviewers, competency models for other professions and geographic information competency models.

3.4.2 Competency List

This section first explains how the initial list of competencies was developed, categorised and assessed.

Geographic information competencies were specified by EAP reviewers during primary data collection. It is important to mention that the pilot interviews assisted to get the first list of geographic information competencies required in EIA review. These were the understanding and interpretation of geographic information, processing geographic information, some form of basic training in GIS in order to make use of Listing Notice 3[7] maps or geographical areas (refer to Section 2.4.1), map reading, critical thinking, analytical thinking, and familiarity with the GIS tool. Then the survey participants rated them on a 5-point scale (very important, important, fairly important, slightly important, and not important). The ratings showed the significance of geographic information competencies. None of the geographic information competencies were rated as not important (refer to Figure 4-10).

During the interviews, the researcher requested interviewees to provide at least three geographic information competencies that were required to review EIAs. Each interviewee listed two to three competencies, and some explained why a particular competence was important in EIA review work.

The researcher then analysed the initial data and identified duplications and drew up the list shown in Table 3-1 and Annexure 5.6.

[7] More information about Listing Notice 3 is provided in section 2.3.

Table 3-1: The list of geographic information competencies required in order to review EIAs as identified by interviewees

1.	Geography
2.	Map reading
3.	Interpretation
4.	Environmental science
5.	Knowledge about ecology
6.	GIS knowledge (Introduction to GIS)
7.	Map reading
8.	Interpretation
9.	Data acquisition
10.	Vegetation classification
11.	Spatial data analysis
12.	Map production
13.	Database management
14.	Practical knowledge
15.	How to draw measurements
16.	How to identify features
17.	How to draw boundaries
18.	How to use GIS tools
19.	How to collect data using GPS
20.	Digitising
21.	Application of spatial knowledge
22.	What kind of layers would be required for an EIA and how to access them? Layers such as archaeology, biodiversity, air quality, waste, social issues.
23.	Analytical methods – basic analytical methods query, identify, query, to check site sensitivity.
24.	Map production, in relation to Listing Notice 3 or in preparation for site visit.
25.	Critical thinking skills
26.	Knowledge about other related courses
27.	Computer skills
28.	Mathematics
29.	IT - Knowledge about IT issues (networks, software types)
30.	Processing and manipulation for a specific EIA.
31.	Qualification - Other interviewees mentioned qualification level for GIS should be a Diploma or Degree).
32.	Training (Accredited training or short courses in GIS)
33.	Both GIS and Environmental management

With respect to number 10 in Table 3-1 vegetation classification was justified by one respondent:

> *"To classify the slopes and vegetation that happen in that particular place. In EIA, geographic information should be used to check the appropriate slopes for*

> *development. For nature conservation, it will be good as a management tool for burning purposes. We can use GIS to check which methods to use for burning whether we use helicopters or people."*

With respect to number 33 in Table 3-1 regarding both GIS and Environmental management, one respondent said:

> *"Practical knowledge of environmental management and the EIA process. It has to be done as early as possible at varsity. So students can go through the normal module of GIS, but they need to have practical side of the tool in the EIA, practical application in the EIA review, that, practical aspect needs to come from the university. So there could be a case study that students work on, they look at a particular site, they screen that site to determine the impacts so that when they become practitioners, they know this is how the tool is applied".*

The next step was to compare the draft list of geographic information competencies in Table 3-1 with existing competency models. The review of the literature guided the development of the taxonomy in Chapter 7 (DiBiase et al., 2007; DiBiase et al., 2010; Englander et al., 2013; Coetzee et al., 2014; Du Plessis & Van Niekerk, 2014) as well as personal communication (D Marais and Z Oumar, 2021). Both Mr Marais and Dr Oumar are senior officials in the SIM Directorate in the DFFE.

In order to avoid redundancy, the literature review was used to craft the domains of competence and competencies. The literature review was used to structure the list of geographic information competencies from the first list that was received from 21 interviewees to the list that is presented in Table 3-1. In that way, literature assisted with terminology, reducing duplication and redundancy.

During the literature review on related work (refer to Section 2.10) there were three main issues observed about competency models. First, there were significant similarities in geographic information competencies for the GISc community or geospatial workforce (DiBiase et al., 2007) and the results of this research, except that the content of the geographic information competencies from this research were related specifically to EIA report review work. Second, competency models have been structured in different ways, such as hierarchical or in words only. Categories have differed from one model to the other. Third, the use of terminology has differed. Other models have used domains of competencies and list of competencies.

Based on the analysis of the points above, the taxonomy approach was used.

3.5 Method for Developing the Taxonomy of Geographic Information Competencies

During the literature review on related work (Section 2.10), it was noticed that there is no prescribed process to develop geographic information competency models as it usually happens with government processes. For example, the EIA process is done according to a legislative framework (refer to Section 2.4). Parts of the journal paper "Towards a task taxonomy for geographic information in decision-making for environmental management the taxonomy", are based on this section (Hlela et al., undated). It includes these common elements which are explained below.

a) The taxonomist gathers data about the subject

A taxonomist gathers data about the subject, which could involve observing an object, such as animals, like in the case of Simpson's taxonomy (Simpson, 1961). Alternatively, it could involve talking to experts in the field or reviewing information from peer-reviewed papers and policy documents, and then synthesising them (Nickerson et al., 2013; Rautenbach et al., 2017).

b) The taxonomist identifies classes and relationships between them

Categories and sub-categories, also sometimes called domains and sub-domains, are identified and then arranged into logical groupings. Classification of things helps to understand a phenomenon. Ranganathan (1951) and Nickerson et al. (2010) stated that it is of 'neural necessity' for people to put some form of order. This basically shows that people want some form of order in life.

> "Shared language is important in leading adaptive change. When people or professionals, EAPs in the case of the research, start using the same words with the same meaning, they talk to each other with clear understanding. Therefore, there will be less confusion about the terms, even where there are differences of opinion. Therefore where there is shared language and clear understanding of the terms being used, even where there are differences in opinion, professionals will understand areas of agreements and areas of disagreements" (Heifetz et al., 2009:9).

The degree of classification defines the efficiency. As Ranganathan (1951) stated, "Sharpness in thinking, clarity in expression, expedition in response and exactness in service depend ultimately on helpful order or good classification" (Ranganathan, 1951:25). Hence, other researchers have said that it is used to identify common language for discussion purposes among various people or researchers within a particular field (Krathwohl, 2002; Leem et al., 2004; Avizienis et al., 2004; Nickerson et al., 2009; Manktelow, 2010; Englander et al., 2013; Nickerson et al., 2013; Kumar et al., 2015). Simpson (1961) acknowledged that sometimes it may be difficult to separate a characteristic into different classes. Sometimes there could be overlaps amongst the characteristics of different species.

One of the common elements in a taxonomy for educational objectives is that they define tasks with increasing levels of complexity. This element is found in taxonomies for assessing some level of competence (Krathwohl, 2002; Rautenbach et al., 2017; Riggs and Gordon, 2017).

Simpson (1961) said that a taxonomy also focuses on finding relationships. It could be relationships in the evolution of certain types of species or in ancestral descendant lines. A taxonomist identifies similarities and differences and then creates new classes. This whole identification of classes and characteristics, including relationships and possible overlaps, contributes to the structure of the taxonomy.

c) Taxonomy development is subjective

What appears to be common is that the process of developing a taxonomy is actually subjective (Bailey, 1984; Scheepers et al., 1986; Leem et al., 2004; Avizienis et al., 2004). Calkins and Obermeyer (1991) used the word 'exception' instead of 'subjective'. Fiedler et al. (1996) used the word 'bias'. Simpson (1961), instead of using the word 'subjective', referred to ingenuity and personal taste. He stated that classification is a science of art because it involves a great deal of human creativity. Furthermore, he argued that it is a science of art which allows ingenuity. It is the art that gives flexibility to personal taste. This flexibility of personal taste makes classification better, more meaningful and more useful. That is, he saw taxonomy as being better than classification because of the freedom that allowed for personal taste.

However, Simpson (1961) argued that there should not be a lot of emphasis on the discussion of reality or objectivity or unreality or subjectivity of taxa. He said that this is a futile discussion or mere semantics. He said that some procedures are arbitrary, meaning they are not based on a principle, plan or system, but rather on personal, indiscriminate or inconsistent choice. Although Simpson (1961) did not use the word 'subjectivity', what he explained was a subjective element of a taxonomy.

d) The structure of the taxonomy can be presented in different ways

The literature review showed that the structure of a taxonomy could be depicted in words alone (Bloom, 1979; Calkins & Obermeyer, 1991; Coleman et al., 2009; Gervais, 2009; Castelein et al., 2010; Englander et al., 2013) The structure for a words-only format has been included here because it has relevance to this research. Other structures have not been used.

One must add that taxonomies come in many different structures (Sneath & Sokal, 1973). The taxonomy shown in Figure 3-2 is of relevance to this research. The structure of the taxonomy and the relationship of classes have been influenced by the purpose of the taxonomy. Nickerson et al. (2013) stated that the purpose of the taxonomy would influence the choice of meta-characteristics of the object being analysed.

Reference list of General Physician Competencies

1. Patient Care

Provide patient-centred care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health.

1.1 Perform all medical, diagnostic, and surgical procedures considered essential for the area of practice.

1.2 Gather essential and accurate information about patients and their conditions through history-taking, physical examination, and the use of laboratory data, imaging, and other tests.

2. Knowledge for Practice

Demonstrate knowledge of established and evolving biomedical, clinical, epidemiological and social-behavioural science, as well as the application of this knowledge to patience care.

2.1 Demonstrate an investigatory and analytic approach to clinical situations.

2.2 Apply established and emerging bio-physical scientific principles fundamental to health care for patients and populations.

Figure 3-2: Reference list of General Physician Competencies (Englander et al., 2013)

e) Taxonomy development is an iterative process

Experience has shown that the development process involves a couple of versions before the final version. Simpson (1961) stated that a taxonomist does classification with a "…good deal of overlapping, jumping and backtracking" (Simpson, 1961:108). The revision may be because a taxonomist has realised that there are new characteristics to be added, or the opposite could be true, that there are some to be deleted (Ranganathan, 1951; Tory & Moller, 2004; Cooper, 2016).

f) The taxonomist has to end taxonomy development at some stage

A taxonomy must be concise, sufficiently inclusive, comprehensive and extendible (Greenberg, 1987). A taxonomist could end a taxonomy in either a subjective manner or in an objective manner (Nickerson et al., 2013). What is key is that the breaking down of classes or levels is exhaustive enough, but if done in a group, it could lead to a state of analysis paralysis (Cooper, 2016).

g) A taxonomy is not perfect

The analysis of taxonomies has also revealed that there is no classification which is flawless (Forehand, 2010). Hence they are revised if there is a need to revise. When a taxonomist classifies a phenomenon, the classification is based on the available knowledge at the time of classification. It could be revised as a result of new information being available. This is even more so in disciplines that are transitory in nature, like information systems (Forehand, 2010; Nickerson et al., 2013).

Bloom's (1956) original taxonomy of educational objectives has been revised by numerous authors including Anderson et al. (2001) and Krathwohl (2002) just to mention two. Forehand (2010), in her independent review of Bloom's taxonomy, mentioned a number of authors who have made changes to Bloom's taxonomy. These changes have included terminology, structure and emphasis. It was on this basis that Forehand (2010) stated that a taxonomy should be considered as a work in progress. According to Simpson (1961), classification should be revised when changing knowledge tends to make it definitely less useful or reveals inconsistency.

This section has shown another contribution of taxonomy in this research. The common elements of a task taxonomy have contributed to guiding the development of the taxonomy for geographic information competencies presented in Chapter 7.

3.6 Factors Influencing the Design of Mixed-Methods Research

It is important to explain factors that have influenced the application of the mixed method approach in this research. These factors include timing, weighting and mixing (Creswell & Creswell, 2017).

3.6.1 Timing

In mixed research, data can be collected concurrently or sequentially. The nature of the project determines the approach to use. Since this research had specific timeframes, a concurrent approach was followed, because it allowed collection of both quantitative and qualitative data concurrently, whereas the sequential approach would not have been really appropriate in the context of the specific time frames for this research.

The sequential approach requires the researcher to first gather one type of data, either quantitative or qualitative, then use results to collect data for the next phase. The researcher can collect quantitative data and use the results to design questions for the interviews (qualitative) to get a better understanding of those issues of interest that came from the survey (quantitative) data.

Gathering of both types of data is a rigorous and time-consuming process. However, collection using the concurrent method, also called convergent (Creswell & Creswell, 2018), was better in the sense that data were collected simultaneously, unlike in a sequential approach, as designing questionnaires is a rigorous process and collecting data is time consuming, taking into account sending follow-up reminders (refer to Annexure 3.5). The concurrent method was better than the sequential method in this research (Creswell & Creswell, 2017).

Although the concurrent method was better from a time perspective, there was still heavy work involved. Qualitative (interview) data were collected from officials reviewing EIAs from departments concerned with environment in the country over a period of four months, that is, from December 2019 to March 2020, with one exception, the first interview that was done in July 2019. Quantitative (survey) data were collected over a period of five months from November 2019 to March 2020.

3.6.2 Weighting

Weighting is about which form of research, quantitative or qualitative, is given priority over the other. In some studies, both methods will have equal weight. In some studies the quantitative approach will be given more priority than qualitative, but the opposite is also true (Creswell & Creswell, 2017).

Data collection was done concurrently in this research, meaning that both quantitative and qualitative methods were given equal weight. This was influenced by the research aim and objectives.

3.6.3 Mixing

Mixing of data in research project happened at different stages, that is, either during data collection or data analysis or data interpretation or right through all these phases. Some of the ways of mixing data include connecting, integrating, and embedding.

Creswell and Creswell (2017) and Creswell (2017:213) explained that in a concurrent triangulation (another form of mixing) method, both forms of data are collected at the same time or almost the same time and they are treated equally, although sometimes one might be given more weight. After collection, data are compared with the intention of confirming or finding areas of convergence, cross-validation, corroboration, or difference. In this study both approaches were given the equal weight in order to achieve the study aim and objectives. Both survey data and interviews were collected concurrently from officials reviewing EIAs in the departments concerned with environment in the country, South Africa.

The quantitative data (survey) and qualitative data (interviews) were collected at roughly the same time in this research from employees reviewing EIAs. Survey data were collected from November 2019 to March 2020. Interviews were conducted from December 2019 to March 2020. Figure 3-3 provides the visual model for this research which is in line with concurrent research design. The meanings of signs (notations) used in Figure 3-3 are provided as follows:

> "Capitalisation indicates a weight or priority on the quantitative or qualitative data analysis, and interpretation in the study. In a mixed methods study, the qualitative and quantitative data may be equally emphasised, or one may be more emphasised that the other. Capitalisation indicates that an approach or method is emphasized. "Quan" and "Qual" stand for quantitative and qualitative respectively, and they use the same number of letters to indicate equality between forms of data. Boxes highlight the quantitative and qualitative data collection and analysis" (Creswell and Creswell, 2017:210).

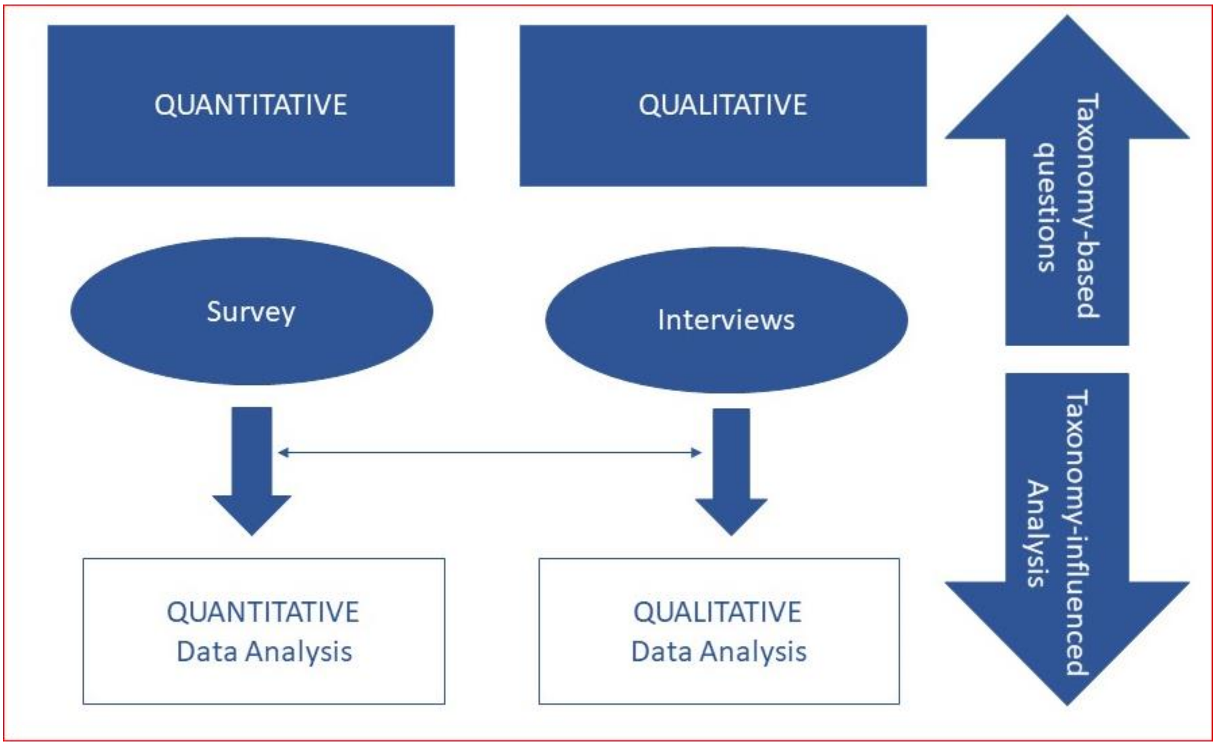


Figure 3-3: Visual model for the research strategy adapted from (Creswell and Creswell, 2017)

3.7 Preparations for interviews

The ethical clearance for undertaking the study was granted before the actual study could be undertaken (Annexure 3.1).

The process to get ethical clearance involved writing to the Director-General (DG) of the national department to grant approval to conduct the study. At the time of writing the letter, the national department was called the DEA. The name has since changed to DFFE. The request for ethical clearance was done as the officials from the departments were going to be participants in the study. Through the DG, all Heads of Departments (HOD) for all provincial environmental affairs departments were also requested to grant approval. All the letters of support that were received were sent to the University Ethics Committee. It should be noted that some of the names have since changed (Annexure 3.1).

The database for all officials reviewing EIAs was already available to the researcher, as the researcher is the employee of DFFE. However, further clarity had to be obtained. Middle managers were contacted to verify the names and contact details of officials in the database. Middle managers were requested to provide more names if there were some missing from the database. They were also requested to delete names that were not supposed to be in the database.

Preparations also included preparing the guiding questions (Annexure 3.3) in consultation with the promoters and the statistician. This was done to ensure that the questionnaire had the questions that could provide answers to the study objectives.

Other preparations that were done included conducting pilot interviews. Pilot interviews were conducted face-to-face with three officials from the national department. The pilot included officials from different ranks in the interest of getting different views. The pilot assisted a great deal in clarifying questions and checking understanding of questions by another person. It also assisted the researcher to test how to ask questions and measure the time needed. As a result, the actual questionnaire that was sent indicated how much time it might take to complete the interview. This helped in terms of allocating the time for interviews as officials are busy people.

Requests to participate in the interviews were done through an email and telephonically. The questionnaire was sent prior to the interviews. Preparations for interviews included arranging the venues and the relevant instruments for conducting the interviews. Quiet places (boardrooms or an office as) were booked in advance.

Prior to each interview, preparations included testing Otter or a standard cell phone recorder for recording. Ensuring that the cell phone had available data had to be done, as it would be unprofessional or very disturbing to run out of data in the middle of the interview. Through practice, one learnt that if the internet is available, the interview can be recorded by opening Otter on the laptop, which means there is actually no need to have data bundles on your phone to record interviews, only airtime for making a call. Therefore, Otter was found to be cost saving. Preparations also included practising asking the questions so that when conducting the real interview, it did not sound as if the researcher was reading.

3.7.1 Sampling for interviews

The second objective of this research is to distribute a questionnaire and conduct interviews with officials in the DFFE and all nine provincial departments in order to assess their perceptions and opinions about the use and value of geographic information in EIA review and decision-making and about competencies required for this. Preparations undertaken involved ensuring that officials that could assist in responding to this objective were selected.

Population includes all the subjects or objects that conform to a set of specifications (Bryman, 1989).

In this study all the officials involved in the review and decision-making for EIAs at DFFE and nine provincial departments formed the population. This would have meant, including officials of all ranks, from the highest, that is, the DG, to the lowest rank, that is the Environmental Officer Grade A. This is where purposive sampling was useful. Purposive sampling allows the researcher to select information-rich participants.

"Purposive sampling allows the researchers to first understand and then reveal significant issues rather than on generalizing from a sample to a population" (Patton, 1999:1197).

There are different methods of purposive sampling, but what is critical is that the respondents chosen are compatible with the aim of the study. Chosen respondents need to be able to provide the researcher with information that will assist in responding to the research aim and objectives (Patton, 1999).

The primary instrument in data collection for qualitative interview is the researcher. Therefore, the experience that the researcher brings in the research is important and it has potential to affect credibility of the research.

The researcher's experience in reviewing EIAs and writing decisions played a key role in selecting information-rich participants. Only officials from the most junior, that is, Environmental Officer Grade A, B up to C are really involved in the review of EIAs and preparing decisions for senior management. The next level is Control Environmental Officer Grade A. Depending on the nature of the office, some officials at this level start to get involved in management issues. In some offices they are still also heavily involved in the day-to-day review work. As for officials above these levels, that is the Control Environmental Officer Grade B, it also depends on the nature of the office, some sign-off on decisions (authorising developments). Some officials at the level of CEO Grade B have delegated powers in terms of NEMA, (1998) as amended. NEMA section 42 allows the DG or the HOD to delegate powers to officials. This means they are no longer involved in the day-to-day work of reviewing, attending site visits and preparation of environmental authorisations.

3.7.2 Data collection methods and techniques for interviews

Data were collected for a period of four months, from December 2019 to April 2020 with one exception; the first interview that was done in July 2019. The intention was to conduct two interviews per competent authority (CA) or per department. There was one official who requested to be part of the interviews instead of responding to the survey questionnaire. Therefore, in total 21 interviews were conducted. As the participants were located all over the country (see map in Figure 3-1), 19 out of 21 interviews were done telephonically. Participants were also requested to sign consent forms as confirmation that they agreed to participate, and they could withdraw at any time without negative consequences. No withdrawals happened, instead, there was even one extra interview.

During the interview, the researcher always started with the introductory part in the guiding questionnaire. The introduction included explaining the purpose of the interview, informing the respondent that participation was voluntary, how the data from the interview would be stored and also requesting the participant to sign the consent part of the form.

Prior to the commencement of each interview, the researcher requested the participant's consent to record the interview. Participants were also informed that their names would not be given in the thesis unless there was a specific written agreement between the official and the researcher. The Otter application and cell phone were used to record interviews. One of the good features of Otter application is that it converts speech to text. The researcher requested that interviews are done in English for the sake of Otter. The researcher also explained that one person would speak at a time as Otter records and converts words to text as they are uttered. In addition to recording the researcher also took notes and that method was found to be extremely helpful. It made it easier to start writing the responses in an Excel spreadsheet. Only two interviews were conducted face to face, for those in the same office as the researcher. The remaining 19 were conducted telephonically.

After the end of the interview, the researcher listened to the interview and transcribed it using Excel. Transcribing involved writing the responses in an Excel spreadsheet and analysis of some responses. The advantage with Otter is that it converts words to text, therefore it reduces the job for the researcher. Another advantage is that one can still listen to the audio and correct any words that were written incorrectly. The disadvantage is that of accent, since it needs to be trained to understand different accents, confusing, for example, “Grace” with “Chris”, or “explore” with “Laura”. The benefit is that you can still listen to the interview and then correct what was captured incorrectly because of the accent issue. Therefore, listening to audio really helps during the process of transcribing interviews.

3.8 Preparations for the survey

Some of the methods that were used for interviewees were also used for the survey, such as the preparations for the survey questionnaire (Annexure 3.4).

A pilot study was also undertaken for the survey questionnaire. Questionnaires were sent to three officials. They were asked to record how much time it actually took them to complete the questionnaire. This helped to write the time in the actual survey questionnaire sent to participants.

Testing the questionnaire was also done with supervisors and the statistician using the Qualtrics online survey tool (Support, 2019). Qualtrics Support unit was consulted during this process to assist in designing and testing the questionnaire using Qualtrics.

Since there were problems in receiving responses through Qualtrics, email had to be used. The researcher enquired from another senior official about the reasons for these problems. The reasons for not receiving the survey were as follows: they had firewalls; could not access Google Earth; limitations on emails; and they spent most of the time deleting and archiving received emails in order to create space for the new ones.

Three examples of benefits of doing preparations prior to sending the questionnaire to the respondents will be mentioned.

Preparations included completing the questionnaire. Testing helps in designing the questionnaire and removing inconvenient issues. For example, dotted lines or solid lines for providing responses were removed, because as participants completed the questionnaire these lines kept shifting around. So blank spaces were left for responses.

- Addressing omissions: There was also a question that requested a response to be put in an appropriate box. During testing it was found that there was no appropriate box provided.

- Testing the time, it took to complete the questionnaire: when the questionnaire was sent it was indicated how much time it should take to complete it. This was important as participants are also really busy people.

Therefore, preparations are an important part in data collection by survey questionnaire.

3.8.1 Design of the questionnaire

The second objective of this survey is to assess benefits of geographic information in EIA review and decision-making. In addition, it is about assessing understanding of geographic information competencies in decision-making, especially in EIAs, so the design of the survey questionnaire included questions to achieve this objective. The questionnaire included questions about indicating workplaces, number of years reviewing EIAs, qualifications, education and training in GIS, also in remote sensing. These questions were included to establish experience in the review of EIAs and level of training in GIS as well as in remote sensing. There were also questions about the use of geographic information in EIA review, specifically who benefits from use of geographic information in the EIA context. There was also a question to check participant's awareness of terms, such as SASDI and SDI, as these form an integral part of the geographic information field.

A 5-point Likert scale was used in some of the questions. For example, to rate the importance, a 5-point Likert scale of "very important", "important", "fairly important", "slightly important" and "not important" was used. The respondents were asked to indicate if they agree or disagree with something by selecting one of the options "strongly agree", "agree", "neither agree nor disagree", "disagree", "strongly disagree".

3.8.2 Sampling for the survey

The quantitative research approach is most appropriate in cases where there are a large number of cases involved and the researcher wants to express significance of the issue using figures. Numbers and percentages make expression of data quicker and more expressive.

Purposive sampling was also used for the survey questionnaire in order to target information rich participants.

There are 36 offices (see map in Figure 3-1) for environmental affairs in the country and almost 200 officials reviewing EIAs. Survey was the best method to reach out to all offices. Similar to interviews, information-rich participants were targeted, that is, environmental officers from grades A to C. They do the actual reviews, go to site visits and prepare decisions.

3.8.3 Data collection and techniques for the survey

Survey data were collected for a period of five months, from November 2019 to March 2020.

An email was sent to all participants requesting participation in the survey. The cover email requested participants to click on the link as the survey was done through Qualtrics. It also included the amount of time it should take to complete the survey, which was about 20 minutes. The inclusion of time was done so that they could see that responding to the survey would not disturb their whole day. The cover email also included a specific due date for completing the survey.

Reminders were sent after the due date. The advantage with Qualtrics is that reminders only go to those who have not responded.

On the third month (January 2020) after the survey questionnaires were sent, the response rate was 21%. As this was very concerning, the researcher started sending reminders. The researcher managed to find some of the real reasons about the low response rate. The reasons for not receiving responses were as follows: they have firewalls; cannot access Google Earth; have limitations on emails; and they spent most of the time deleting and archiving received emails in order to create space for the new ones.

As a result of these difficulties, the email was used to send questionnaires. Where responses were not forthcoming, follows-ups through emails, and telephone calls where necessary were done (refer to Annexure 3.5). What also assisted was to communicate with some of the section managers to find out if all relevant officials had received the survey. Consulting the relevant section managers assisted, as they are the ones who work directly with the identified respondents. Section managers also assisted in sending the questionnaires to additional people that were not included in the initial email (refer to Annexure 3.5).

In total, questionnaires were sent to 157 EIA officials across the country. This included the most junior levels to some of the middle managers. In total 94 participants completed the survey. Forty-six responded through Qualtrics. Fifty responded through email. Four responded using both Qualtrics and email. The survey response rate was 60%. Towards the end of the questionnaire, participants were requested to indicate by ticking ‘yes’ or ‘no’ their willingness to validate the responses. The majority of officials (86%) agreed to be available. Only 14% indicated that they would not be available. All interviewees indicated they could be contacted for validation purposes.

3.9 Data analysis

Triangulation was used in data analysis to ensure reliability and validity of the results (Denzin, 2018). Methods used in data analysis are thematic content analysis, and document analysis. The Statistical Package for Social Sciences (SPSS) programme was also used for data analysis.

Thematic content analysis was used to analyse primary qualitative data. However, since taxonomy was used to structure the guiding questionnaire, this process was less burdensome compared to collecting data without categorising it into themes and sub-themes. The analysis of the results has led to the reconceptualisation of those themes. The analysis of the results does not necessarily follow the order of the themes as in the guiding questionnaire. Hence the discussion in Chapter 6 is based on emerging issues or what became prominent (Teddlie and Tashakkori, 2010). Therefore the development of topics and sub-topics in Chapter 6 is based on the issues that were critical. Informative quotes were used to substantiate the discussion. Quantitative data obtained from the interviews have been reported using numbers distribution.

The qualitative data were collected using Otter and then stored and transcribed in an Excel sheet. Field notes were written during the interviews and were used during the recording of data into Excel.

The survey questionnaire was designed to generate mainly quantitative data. The percentage distribution was used to analyse quantitative data (questions 1, 2, 3, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 21). Content analysis was used to analyse primary qualitative data (questions 4, 10 and 20) received from the survey.

The data collected from the survey questionnaire were stored in Excel spreadsheets. Descriptive statistics were calculated using SPSS. The Fischer exact test was used to analyse any associations in responses to certain questions (question 8, 10, 13, 16 and 17 in Annexure 3.4, survey questionnaire) based on the number of years in the field, levels of education and training in GIS and or remote sensing.

Document analysis was used mainly to address the first objective about use of geographic information in EIA review. Participants were asked if they were aware of any academic documents regarding the use of geographic information in EIA review (refer to question 25 in Annexure 3.3, that is the guiding questions and question 21 in Annexure 3.4, survey questionnaire). Document analysis was done from the list provided (refer to Annexure 4.3).

Concurrent analysis of quantitative and qualitative data was done. The quantitative data were used to show the significance in percentages of the data received from qualitative data. The qualitative approach was used to elaborate on the quantitative data received from the survey.

3.10 Limitations

Surveys conducted in organisations focus on a sample, as reaching the entire population is not realistic. Endeavours were made to reach as many of the target population as possible. Several reminders were sent to participants. This assisted in increasing the response rate of participants. The limitations about the survey have been discussed in Section 3.4.

There were also difficulties to get appointments with interview respondents as participants were really busy with their day-to-day duties.

In a qualitative approach the personal experience of researchers might impact data collection and analysis (Jackson, 1990). The researcher’s experience is to conduct training on EIAs through contact sessions. It was for this reason that triangulation was used, as it brings objectivity and validity (Fusch et al., 2018).

In order to address influence of personal experience during data analysis, a combination of qualitative and quantitative methods were used to analyse data.

To ensure that there was no bias, because of the researcher’s personal experience, the results presented include a variety of training methods (refer to Section 6.2.4.). The researcher reported the new methods of training based on the results. As a result, one of the key contributions of this thesis is that it has revealed new ways of capacity-building.

3.11 Ethical considerations

The Research Ethics Committee of the Faculty of Natural and Agricultural Sciences of the University of Pretoria approved the researcher’s ethics application before the information-gathering was conducted (reference number 28366086 NAS112/2019). The ethical clearance certificate may be seen in Annexure 3.1.

Permission was obtained before any data collection was undertaken (Annexure 3.2). The DG, HODs and senior officials signed letters, accepting data collection to be undertaken for independent research in their departments. Each participant in the interview and questionnaire signed a consent form. The consent form is attached to the guiding questions and the questionnaire and may be see in Annexures 3.3 and 3.4. Also, where letters from HODs or senior officials could not be obtained, participants signed consent forms. However, in the presentation of results pseudonyms for the departments have been used to ensure anonymity (refer to Figure 4-1 and Figure 5-1). Also, the names of interviewees were not included. Where direct quotations were used, rephrasing of certain words was done to ensure anonymity of the interviewee without losing the gist of the message.

One of the key ethical considerations in any research involving human beings is the exposure to risk for participants (Walker, 2010). All those who were participants either as interviewees or respondents in the survey were not exposed to any risks during the course of the research. Interviews were done face to face in the office and telephonically. In both types of interviews, there was no need for travelling. If there was any, only the researcher would have travelled.

Prior to the start of each interview, participants were informed that participation was voluntary. They were then requested to sign and send back the signed consent. The purpose was explained and the participants were requested to sign and return the signed copy.

The next chapter presents the survey results.

Chapter 4: Survey Results

4.1 Introduction

The presentation of the results in this thesis has been divided into two chapters. Since the data were collected using mixed-methods research, this chapter presents the survey results. The results from the interviews are presented in Chapter 5.

This chapter addresses the second objective of the research, which was to distribute a questionnaire and conduct interviews with EIA officials in the DFFE and all nine provincial departments for environment in order to assess their perceptions and opinions about the use and value of geographic information in EIA report review and decision-making and about the competencies required for this. A quantitative approach was applied to obtain reliable and objective results. This chapter presents the survey data using mainly percentage distribution. Descriptive statistical analyses have been used to provide reliable information without elements of subjectivity in the overall results (Day et al., 2008).

This chapter begins by providing further information about participants as obtained from the survey results. This is followed by the presentation of the questionnaire in a narrative. The presentation of the survey results follows. At the end of the survey, participants were given an opportunity to make comments about the study itself. Their comments are a crucial indicator in terms of how officials value geographic information.

4.1.1 Participants

Ninety-four officials reviewing EIAs participated in the survey. The number of EIA officials involved per department is depicted in Figure 4-1 (question 1). Pseudonyms instead of real names for departments have been used in Figure 4-1 to ensure anonymity for ethical considerations. In terms of the number of years of experience, officials' work experience ranged from one year to 23 years with an average of eight years (question 2).

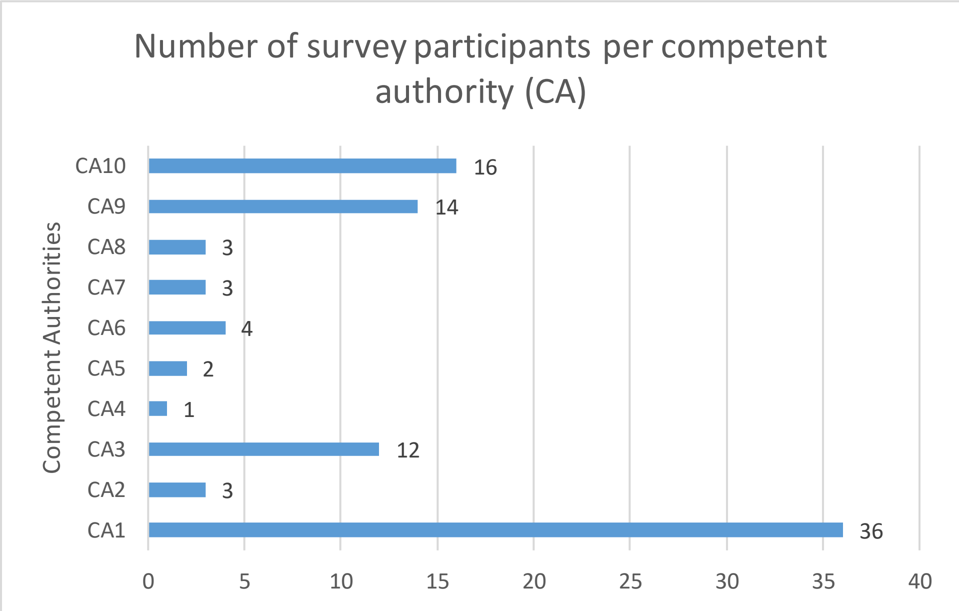


Figure 4-1: Number of survey participants per competent authority (CA) (Question 1)

4.1.2 Questionnaire in the narrative

The survey questionnaire was designed to generate mainly quantitative data to respond to the objectives of the research, particularly objectives two to four. To collect quantitative data, the questionnaire included possible answers and participants were requested to choose their most preferred option. This section then provides the questionnaire in the narrative form.

It included questions about the participant information such as their places of work, number of years reviewing EIAs, qualifications and the education and training in GIS and remote sensing.

Survey respondents were asked if they felt the need to do more courses in GIS and or remote sensing by choosing a yes or no answer. One open-ended question was included for those who chose yes. Respondents were required to state their reasons for not wanting to do more courses. For those who chose no, they were asked to mention at least three skills they would like to improve in order to function effectively.

The next question was to indicate frequency of the use of web and browsing at work, at home, frequency of use of geographic information in EIA reviews. They were also asked to indicate if they have access to geographic information they needed, for the review of EIAs. Frequency rating was done on a scale of 1 to 5 'never', 'rarely', 'sometimes', 'often' and 'daily'.

A five-point Likert scale was used in some of the questions. The respondents were asked to indicate if they agree or disagree with something by selecting one of the options 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree', 'strongly disagree'.

The questionnaire included a question about some of the ways in which geographic information can be used in reviewing EIAs. The questionnaire included statements where respondents had to indicate their extent of agreement or disagreement.

Another question that used a similar rating as above was for respondents to indicate what it took to be able to use geographic information in EIA review. Four possible ways were provided.

The questionnaire provided a list of potential beneficiaries from the use of geographic information in EIA report review. Survey respondents had to choose yes or no with respect to who benefited from the use of geographic information.

Respondents were required to indicate their level of awareness of terms such as SASDI, SDI and Spatial Data Infrastructure Act No. 54 of 2003.

As the development of geographic information competencies in EIA report review is the main contribution of this thesis, the questionnaire included a question to obtain information about their understanding of the importance of geographic information competencies in an EIA review and decision-making. A five-point rating scale of 'very important', 'important', 'fairly important', 'slightly important' and 'not important' was used.

A question about what can be done to encourage use of geographic information by EIA reviewers used a similar five-point rating scale as above. Six ways were provided for respondents to choose from.

Respondents were required to indicate how well the legislation deals with the use of geographic information by officials reviewing EIAs by choosing an answer in the box provided. The answers ranged from 'very well', 'adequately', 'poorly', 'it does not mention use of geographic information at all', to 'don't know'.

Towards the end, the respondents were required to indicate if they would be interested in knowing more about geographic information, and also to indicate whether they were aware of any academic documents that had covered the use of geographic information for EIA review and decision making in South Africa or in any other country.

The next section reports the results for all the questions in the survey.

4.2 Presentation of survey results

Figure 4-1 shows that all competent authorities (national department and nine provincial offices) participated in this research. It also shows (from the sample) how many officials participated per competent authority. This section starts by presenting the abbreviated questionnaire[8] then providing the results of the survey. The abbreviated questionnaire is

[8]Some questions were long, therefore they are presented in a summarised form. However, some shorter questions are written as such. As part of responding to the Examiner's comments and for the sake of clarity about

presented in Table 4-1. The abbreviated form focuses on the contents of the question (what was asked), not the structure of the questionnaire. The full questionnaire is in Annexure 3.4.

Table 4-1: Abbreviated questionnaire

Question 1	Where do you work?
Question 2	Number of years reviewing EIAs
Question 3	What is your qualification? (i.e., Diploma, Bachelor, Honours, Master's and PhD).
Question 4	If the qualification is not any of the above, respondents were required to write that specific qualification.
Question 5	To ascertain how much education and training you have in GIS and / or remote sensing please tick all the boxes that apply to you. Fifteen choices were provided.
Question 6	It was similar to question 5 but focused on remote sensing.
Question 7	Participants were requested to add any other qualification not provided in the choices they were given.
Question 8	For your job do you feel the need to do more courses in GIS? (yes or no).
Question 9	Those who choose 'no' were requested to provide reasons.
Question 10	If you could do more courses in GIS and remote sensing, which knowledge areas or skills you would like to improve to function effectively?
Question 11	They were presented with statements about the use of the web, geographic information and access issues. Then presented with a five-point rating scale to rate their responses.
Question 12	The question included different ways in which geographic information can be used in reviewing EIAs. They had to indicate by agreeing or disagreeing with the statement using a 5-point Likert scale (strongly agree to strongly disagree).
Question 13	EIA officials were requested to indicate who benefits from the use of geographic information in the list of beneficiaries provided.
Question 14	EIA officials were requested to indicate their level of awareness of SDI related issues.
Question 15	What does it take to be able to use geographic information in EIA review? EIA officials had to choose from the options provided.
Question 16	What are the geographic information competencies that are required in order to review EIAs? They were requested to rate the options provided using a five-point rating scale (from very important to not important).
Question 17	What can be done to encourage its use by EIA reviewers. Again there were options to choose from (from very important to not important).
Question 18	How well do you think the legislation deals with the use of geographic information by EIA officials? Again they had options to choose from (from very well to don't know).
Question 19	Would you be interested in knowing more about geographic information?

EIA report review, this abbreviated form uses the term EIA report review, to clarify what exactly is referred to. Whereas the questionnaire used EIA review. However, EIA officials understood what it meant.

Question 20	Would you be happy to use geographic information in the EIA report review?
Question 21	They were requested to tick either yes or no to indicate their awareness about any academic document that has documented the use of geographic information in the review of EIA and decision making in South Africa and in other countries.
Question 22	They were requested to provide the title of such a document.

In Question 3, participants were asked about their qualifications. Figure 4-2 shows that 3% had a Diploma. The majority of participants (51%) held an Honours degree, followed by 27% with a Bachelor's degree. Then 19% had a Master's degree. No participants held a PhD degree. No other qualification (for example a certificate) was indicated (Questions 3 and 4).

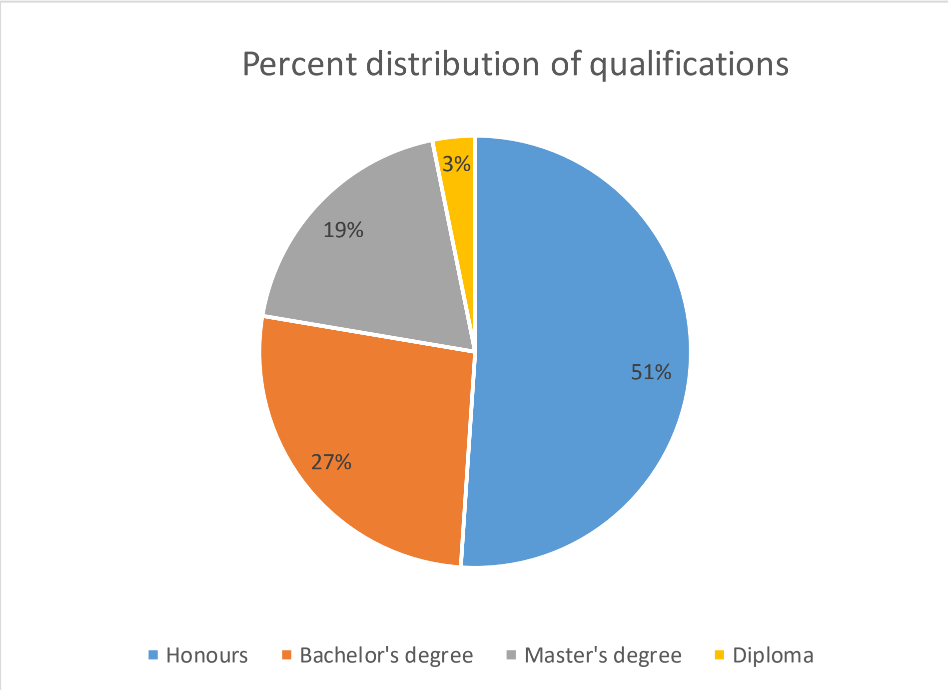


Figure 4-2: Percentage distribution of qualifications for survey participants (Question 3)

In Question 5, participants were asked about their level of education and training in GIS by selecting all the applicable boxes. Figure 4-3 shows all the levels of education and training in GIS that were provided. The results indicate that out of 15 education and training levels that were provided, only five were chosen; 30% had two weeks or less training in GIS. The largest group of participants (42%) had one or more semester modules in GIS education, 11% had a Bachelor's degree in GIS and there was a notable decline in higher qualifications (6% had an Honours degree with GIS courses and 1% had a Master's degree with GIS courses and none had a PhD with a GIS course).

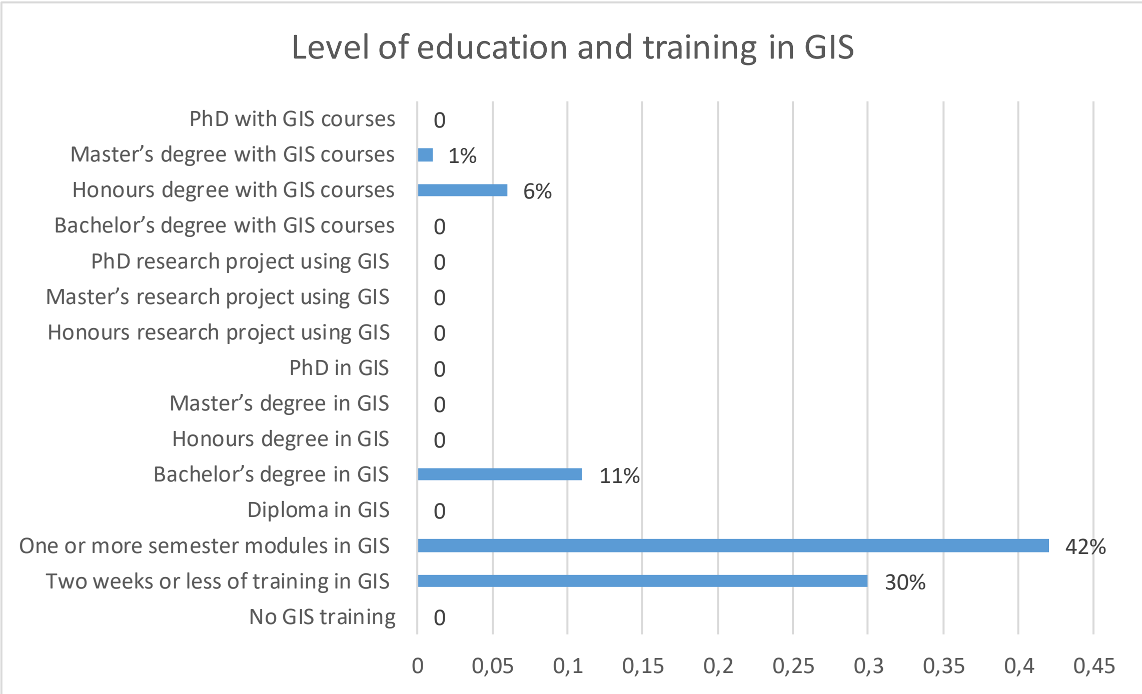


Figure 4-3: Level of education and training in GIS (Question 5)

Figure 4-4 shows the results of education and training in remote sensing (Question 6). A similar trend was noted. Out of the 15 levels provided, five were selected by respondents. Again, in terms of percentages, almost a similar trend was noted as in GIS education, with the biggest group of participants (32%) having one or more semesters in remote sensing. Twenty-seven percent of participants had two weeks or less in remote sensing. Five percent of participants had a Bachelor's degree with remote sensing courses. Three percent held an Honours degree with remote sensing. There were none at Master's and PhD levels with remote sensing.

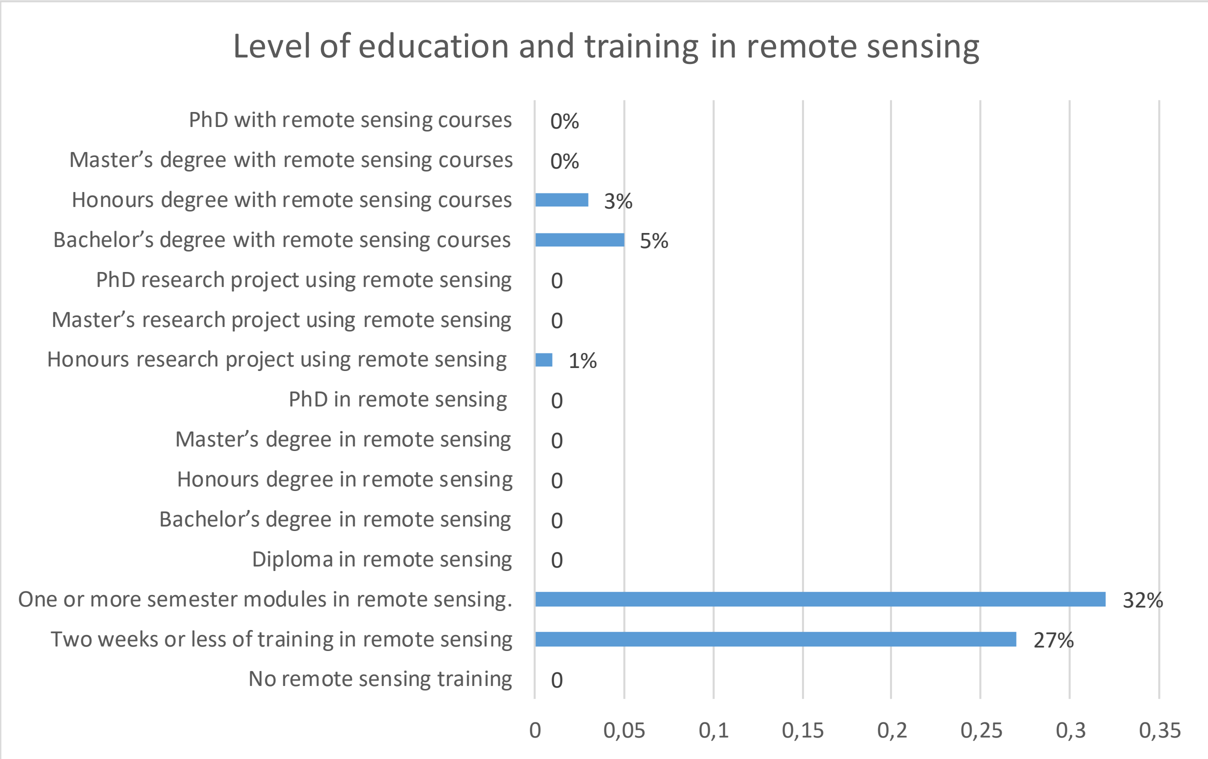


Figure 4-4: Level of education and training in remote sensing (Question 6)

In Question 7, they were also asked to write any other education or training in GIS and remote sensing that might not have been mentioned in questions 5 and 7. Two participants had the GIS certificate from ESRI.

Question 8 was included to establish if, based on the level of education and training in GIS, they still felt the need to do more courses in GIS. 82% were interested in doing more courses in GIS. 18% did not need feel the need to do more courses in GIS.

The Pearson chi-square was performed to test if there is an association between the level of education and training, that is, the responses in GIS training and the need to do more courses in GIS is influenced by their level of education.

The null hypothesis tested is that there is no association between the level of education and training GIS and the need to do more courses in GIS. The alternative hypothesis tested is that there is an association between the level of education and training GIS and the need to do more courses in GIS.

The null hypothesis is rejected if the p-value is <0.05, if the p-value is greater than >0.05 we fail to reject the null hypothesis. We fail to reject the null hypothesis that there is no association between level of education and training in GIS and the need to do more GIS courses ($P > 0.05$) and level of education and training in remote sensing and the need to do more GIS courses ($P > 0.05$). Their responses are not influenced by the level of education.

It was important to establish the reasons for not wanting to do more courses in GIS. Hence in Question 9, participants were asked to provide reasons for not wanting to do more courses. Table 4-2 provides a list of reasons as they were written by survey participants. One common characteristic in these reasons was that some participants felt that they had enough education and training for their work (EIA report review and decision-making).

With respect to doing more courses in GIS and remote sensing, in Question 10 they were asked to provide at least three knowledge areas or skills they would like to improve on, in order to function more effectively. Data confirmed that, irrespective of officials' level of education and training in GIS, they still wanted to do more GIS courses (Annexure 4.2).

Table 4-2: Reasons for not wanting to do more GIS courses (Question 9)

I have obtained all the necessary skills for my job function.
GIS is a tool I use upon reviewing EIA reports. The training and experience I have is sufficient to help me review the EIAs objectively as an end-user.
I am the end-user. I do not require GIS course, only GIS training as an end-user.
DEA has specialised unit for advanced GIS queries, therefore training is not necessary. I possess the basic skills to make use of GIS in my work environment. The use of the DEA screening tool is used to obtain basic information and running queries.
I do not need more training but rather practice of the training that I currently have. Now I am not able to fully use the training I have as I have no access to software.
I enforce Alien Invasive Species (AIS) regulations on mammals; this is not directly dependent on GIS.
There is an existing GIS in the Departmental system that is so easy to use, with the information relevant in assisting to identify the sensitive features for the site where development is proposed. However, the system needs to be updated in order to assist the department to make informed decision.
GIS mapping skills required for my work are basic as there is a GIS section within the Department that handles GIS related queries. With the GIS knowledge that I have gained, I am able to navigate programmes such as Google Earth, Google maps, Renewable Energy Development Zone mapping, as well as interpreting mapping information provided in EIA reports for decision-making.
The EIA Screening tool is now in place and adequate training in how to operate this tool should be sufficient to review EIAs.
I am currently able to read and interpret the geographic information, so I do not think I need more training on that.
EIA only requires me to be able to interpret maps and how to read and understand spatial frameworks in terms of locations and positions of developments. The current understanding and experience of GIS is enough.
The knowledge I have on GIS is sufficient for the kind of work that I do.
The basic techniques I acquired during training are sufficient for the level of GIS applicable to my work.

Annexure 4.2 provides a list of courses. An attempt to categorise knowledge areas has been made to avoid presenting a long list of courses from 94 participants. Each official mentioned

two to three courses. Mostly participants mentioned three courses as Question 10 required. Other participants explained why they would want training on a particular course. The number next to some knowledge areas is an indication of how many times that particular knowledge area appeared in the list (Annexure 4.2).

According to the responses, knowledge areas or skills that were mentioned the most included making and analysing maps, basic GIS, interpretation of maps, how to use geographic information, remote sensing and processing digital images. Knowledge of spatial operation such as identifying sensitive areas was important as in Listing Notice 3[9], the trigger for listing is based on the geographical area.

Figure 4-5 (Question 11) provides results of the frequency of use of web and browsing at work, at home, the frequency of use of geographic information in EIA review (their day-to-day work), and indicating if they had any access to geographic information they needed for EIA review. Figure 4-5 shows how they rated themselves on a 5-point scale, just to focus on the ratings of the use of geographic information in EIA review, as this is their day-to-day work. 27% indicated that they used it daily, 31% often used it, 26% sometimes used it, 5% rarely used geographic information in EIA review, and 6% indicated that they never use geographic information in the review of EIAs. Figure 4-5 also shows the ratings of access to geographic information. Some (22%) participants had access daily, while 15% of officials did not have access.

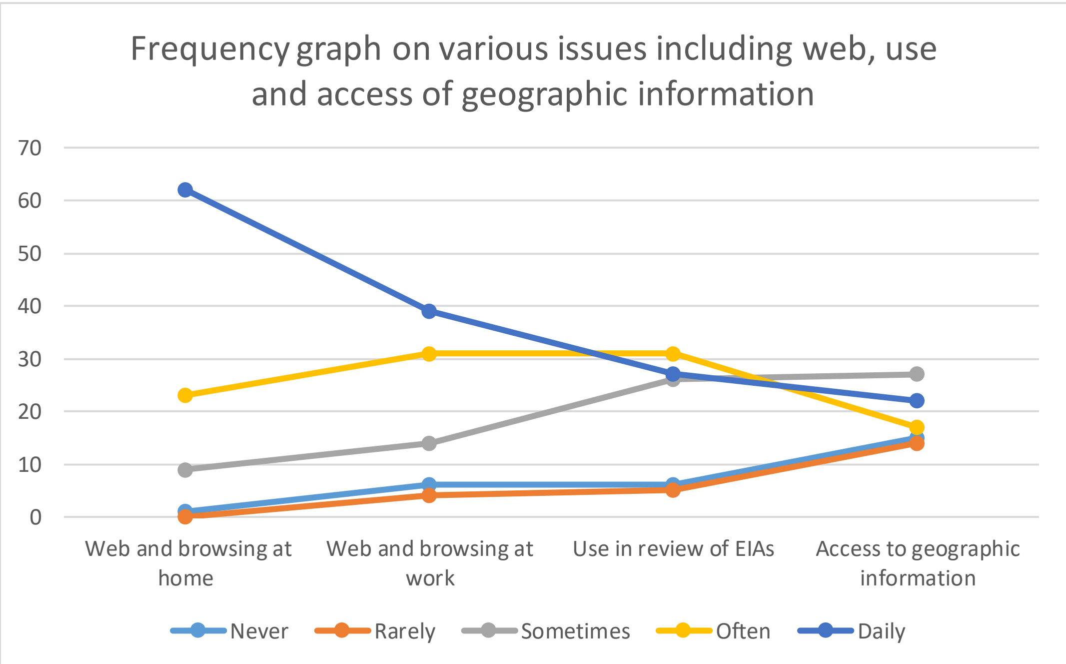
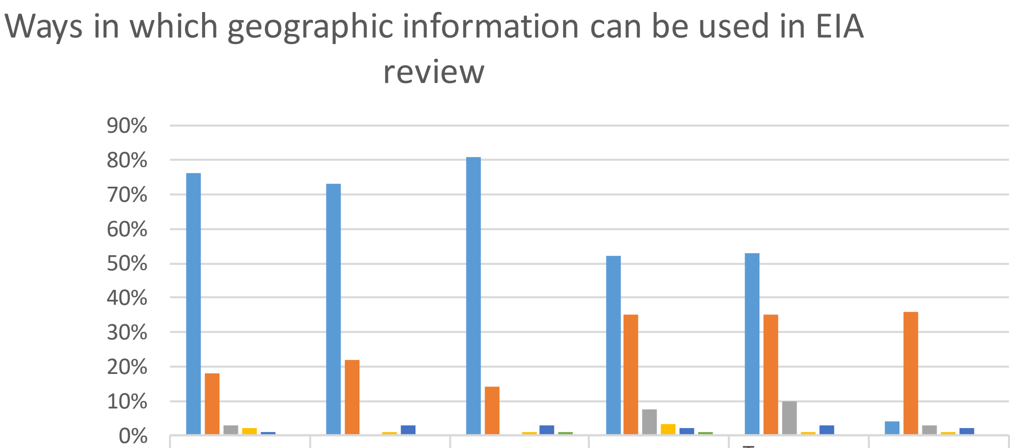


Figure 4-5: Frequency graph on various issues about use of web and including use and access to geographic information for EIA review (Question 11)

[9] More information about the listing of EIA activities is provided in Chapter 2, section 2.4.

In Question 12 participants were requested to rate, on a 5-point Likert scale, some of the ways in which geographic information can be used in reviewing EIAs. They were requested to indicate to what extent they agreed or disagreed with the statements provided. Figure 4-6 shows that higher percentages were given to strongly agree compared to disagree and strongly disagree.

The charts or the tables provide a visual representation of the data or association between the variables, they don't provide a statistical test where inference can be made if the observed association is significant or not, for that reason; the Pearson chi-square was performed to test if there is an association between the number of years and responses to question 12. We fail to reject the null hypothesis that there is no association between the number of years and responses to question 12 and conclude their response to question 12 is independent of the number of years.



	To verify site information	To verify surrounding uses	To visualise the location	To locate proposed developments	To measure trends of developments on the location	To make informed decisions
Strongly agree	76%	73%	81%	52,1%	53%	4%
Agree	18%	22%	14%	35,1%	35%	36%
Neither agree nor disagree	3%	0%	0%	7,4%	10%	3%
Disagree	2%	1%	1%	3,2%	1%	1%
Strongly disagree	1%	3%	3%	2,1%	3%	2%
No answer	0%	0%	1%	1,1%	0%	0%

Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree No answer

Figure 4-6: Use of geographic information in EIA review and decision making (Question 12)

In Question 13, participants were provided with four types of potential beneficiaries of geographic information in EIAs. Given their day-to-day experience in EIA review and decision-making, they were asked who benefits from the use of geographic information by ticking 'yes' or 'no' next to each beneficiary. Figure 4-7 shows that 100% of EIA officials indicated that Consultant EAP, EIA reviewer and decision-maker benefited from the use of geographic information in the review of EIAs. The applicant was also seen as a beneficiary although to a lesser extent (83%) than other parties. Only 17% did not see the applicant as a beneficiary in the use of geographic information.

We fail to reject the null hypothesis the response to question 13 is not influenced by the number of years and training in GIS, (P is > 0.05). The same conclusion is drawn for level of education and training in a remote sensing.

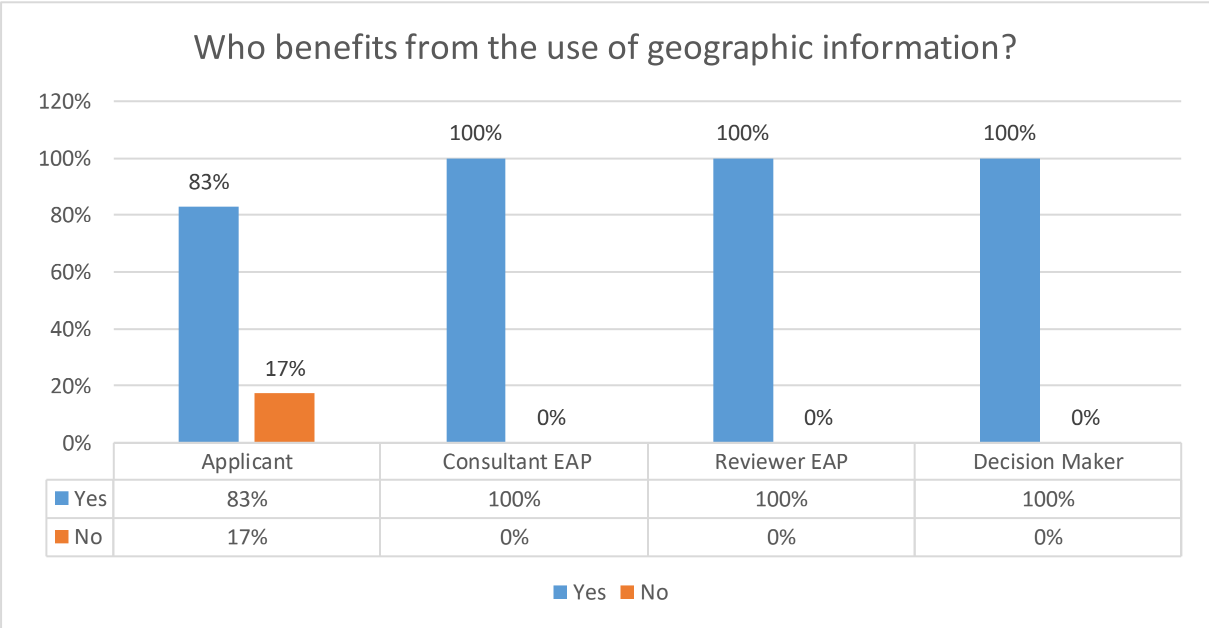


Figure 4-7: Who benefits from the use of geographic information (Question 13)

In Question 14, participants were requested to rate their level of awareness on a five-point scale of the terms as indicated in Figure 4-8. Figure 4-8 shows that 35% to 38% of participants were not at all aware of these terms, SASDI, SDI and SDI Act. It is noted that around the same percentage (36% to 41%) of participants were slightly aware of these terms. Only 1% to 4% participants were fully aware of these terms.

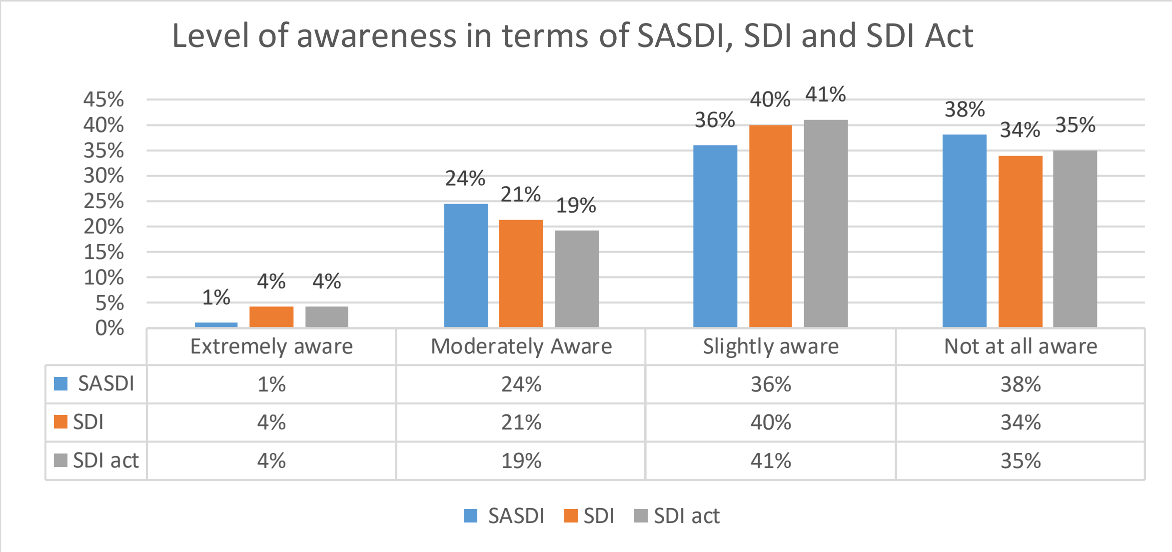


Figure 4-8: Levels of awareness of SASDI, SDI and SDI Act (Question 14)

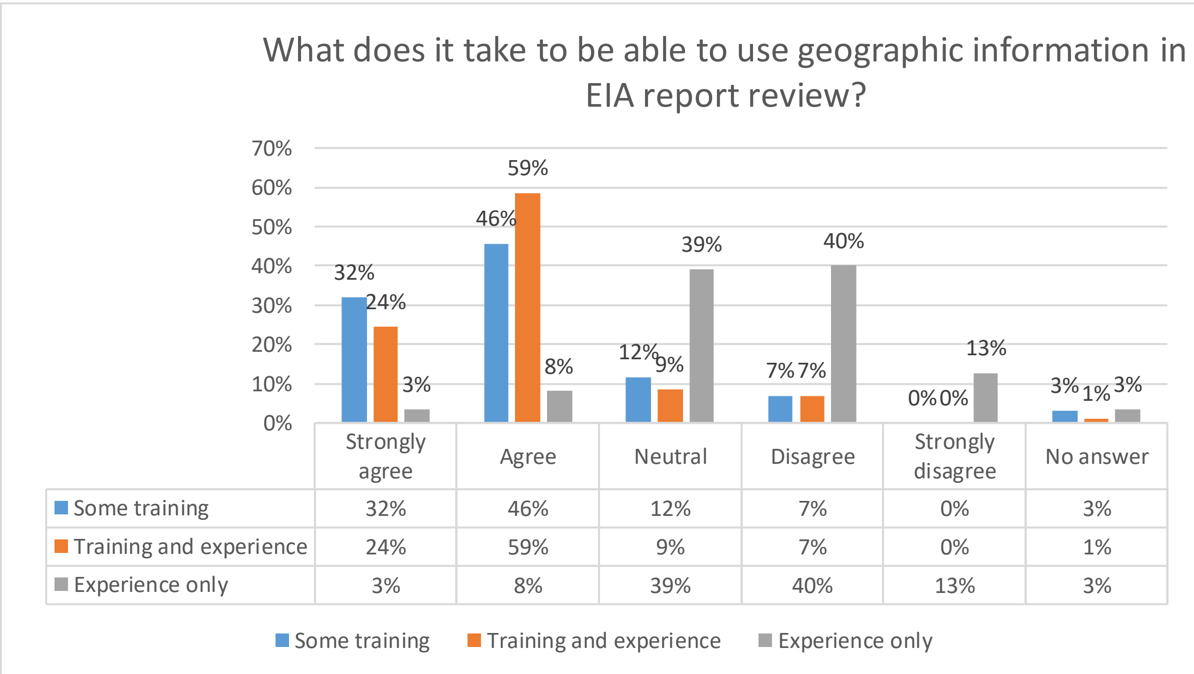
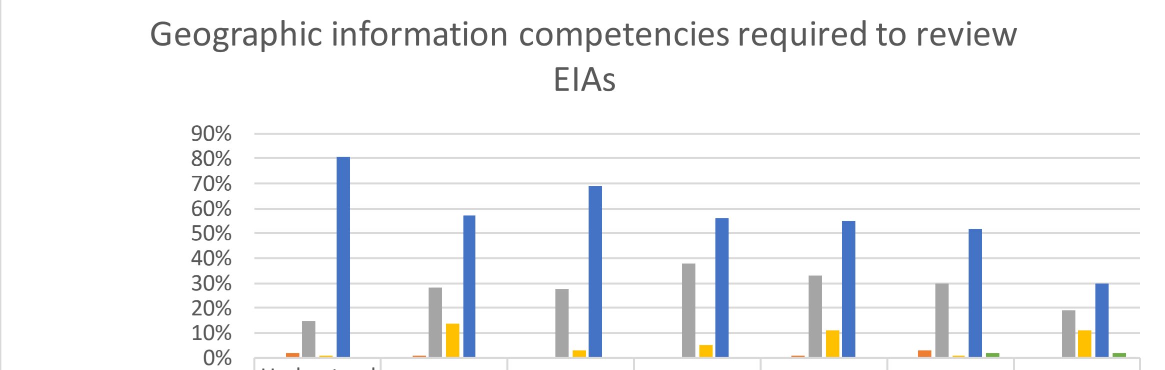


Figure 4-9: What does it take to be able to use geographic information in EIA review? (Question 15)



	Understanding and interpretation	Basic training	Map reading	Critical thinking	Familiar with GIS tool	Analytical thinking	Processing
Not important	0%	0%	0%	0%	0%	0%	0%
Slightly important	2%	1%	0%	0%	1%	3%	0%
Important	15%	28%	28%	38%	33%	30%	19%
Fairly important	1%	14%	3%	5%	11%	1%	11%
Very important	81%	57%	69%	56%	55%	52%	30%
No answer	0%	0%	0%	0%	0%	2%	2%

Not important Slightly important Important Fairly important Very important No answer

Figure 4-10: What geographic information competencies are required to review EIAs? (Question 16)

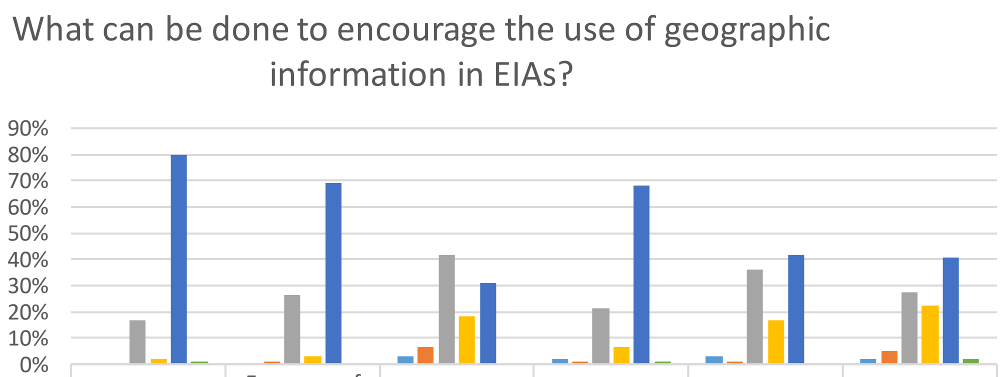
With regard to the understanding of what it takes to be able to use geographic information in EIA review, participants in Question 15 were requested to rate whether each option was sufficient to perform an EIA review. Percentages in Figure 4-9 show that the rating of 'agree' was chosen the most followed by the 'strongly agree' rating. The results revealed that participants regarded training and experience as important.

With respect to the understanding of geographic information competencies that are required to review EIAs, seven competencies were provided (refer to Figure 4-10). Participants were requested to rate them on a 5-point scale, ranging from very important to not important. According to the instruction in question 16, participants were allowed to rate more than one under the same category. Eighty-one percent of participants rated understanding and interpretation as very important, followed by map reading at 69%. Fifty-seven percent of participants rated basic training in GIS to make use of Listing Notice 3 maps as very important, followed by critical thinking as very important by 56% of participants. Familiarity with GIS tools was rated as very important by 55% of participants. Only 30% of participants rated processing as very important. None of the other competencies appeared in the rating of not important.

A Pearson's Chi Square test was performed to assess if there is any association between number of years reviewing EIAs and responses to the ratings about geographic information competencies required for EIA review. There was no significant relationship, ($p > 0.05$). This revealed that the level of qualifications of officials does not have influence on how they responded. They still viewed geographic information competencies as important in EIA review.

We fail to reject the null hypothesis the response to question 16 is not related or influenced by the number of years and training in GIS, (P is > 0.05). The same conclusion is drawn for level of education and training in a remote sensing.

In Question 17, participants were asked what could be done to encourage the use of geographic information by EIA reviewers. Participants were asked to rate the methods, as can be seen in Figure 4-11, which illustrates that, under the 'very important' rating, all the methods except for holding conferences were rated higher, with training of EIA reviewers receiving the highest rating of 80%, followed by exposure of officials to benefits of geographic information at 69%. It is also noted that these two did not even appear under the 'not important' rating, whereas conferences (2%) and GIS station in each office (2%) appeared under the 'not important' rating. Results on capacity building contributed to the third objective, which was about improvement strategies.



	Training of EIA reviewers	Exposure of officials to benefits of geographic information	Case studies	Each office should have a GIS station	Training manuals	Information sharing conferences and seminars
Not important	0%	0%	3%	2%	3%	2%
Slightly important	0%	1%	6%	1%	1%	5%
Important	17%	27%	41%	21%	36%	28%
Fairly important	2%	3%	18%	6%	17%	22%
Very important	80%	69%	31%	68%	41%	40%
No answer	1%	0%	0%	1%	0%	2%

Not important Slightly important Important Fairly important Very important No answer

Figure 4-11: What can be done to encourage use of geographic information in EIAs? (Question 17)

We fail to reject the null hypothesis the response to question 17 is not influenced by the number of years and training in GIS, (P is > 0.05). The same conclusion is drawn for level of education and training in a remote sensing.

In Question 18 participants were requested to indicate how well the legislation deals with the use of geographic information by officials reviewing EIAs. Figure 4-12 demonstrates that 47% of participants indicated that the legislation deals poorly with this matter, 11% of participants indicated that the legislation does not mention the use of geographic information, while 6% did not know what the legislation says. However, 30% of respondents felt that the legislation dealt adequately with this matter. The rating of 'very well' was chosen by 6% of respondents.

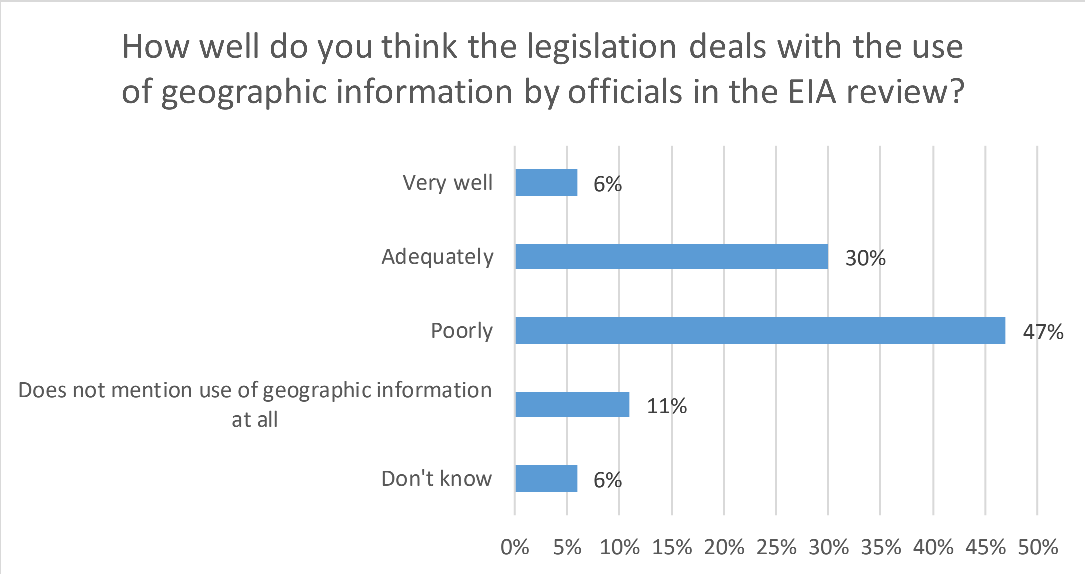


Figure 4-12: Legislation and the use of geographic information by officials (Question 18)

Participants were requested to indicate their interest in knowing more about geographic information by ticking 'yes' or 'no'. 93% of participants had an interest and only 6% were not interested (Question 19).

We fail to reject the null hypothesis the response to question 19 is not related to the number of years and training in GIS, (P is > 0.05). The same conclusion is drawn for level of education and training in a remote sensing.

Participants were requested to tick 'yes' or 'no' as to whether they would be happy to learn how to use geographic information when reviewing EIA reports. 96% of officials indicated that they would be happy. Only 4% were not interested in learning more (question 20).

One of the key contributions of this thesis is to document the perceived value of geographic information in EIA review and decision-making. In Question 21, participants were requested to indicate whether they were aware of any academic document in this regard. They were also requested to provide the title of the academic document and how to access it. The majority of officials (89%) were not aware and only 11% were aware of such a document.

The list of academic documents from the surveys and semi-structured interviews has been combined because only one interviewee provided the title of the academic document and how to access it (Annexure 4-3).

In closing the questionnaire, participants were requested to make any further comments.

Their comments ranged from commending the researcher for the study and wishing all the best. They were grateful to be part of this study. The study was seen as an inspiration.

Some comments indicated clearly that some participants viewed geographic information as invaluable in EIAs for both reviewers (EIA regulators and EAPs (EIA consultants)).

Others took the opportunity to make a request for training in geographic information.

Comments were made about how the study could be improved and about shortcomings in the way questions were worded.

Others took an opportunity to suggest improvements that are required in geographic information and EIA report review.

4.3 Conclusion

All competent authorities, although in varying numbers, participated in this survey. The sampled population included participants with the knowledge of the subject matter, and they are well experienced in the field. The first EIA regulations have been in existence for 24 years. They were promulgated in 1997. Participants in this research included officials with less than five years to officials with well over 20 years of practice.

At the time of writing this study, the EAP qualification had not been formally introduced in tertiary institutions (R Hill, personal communication, 19 March 2021; P Sithole, personal communication, 19 March 2021). Dr Sithole was the current Registrar for EAPASA at the time of writing this thesis. Dr Hill was the former Registrar. Both provided useful information about the uptake of the qualification in tertiary institutions. All participants in this research had a qualification at a certain level (Diploma to Master’s degree). Most participants (51%) had an Honours degree.

The results of this survey have shown that participants use and value geographic information as 82% of the participants strongly agreed that geographic information can be used in various ways in the EIA review process.

However, inasmuch as there were all these positive indicators about the value received from geographic information, there were certain areas of concern about frequency of use, level of awareness of relevant legislation with respect to geographic information, and awareness of SDI topics.

Various methods for building capacity were suggested with training receiving 80%. Results on capacity building contributed to achieving part of the third objective, which was to recommend improvement strategies.

The use of statistical analysis has assisted to test the significance of responses, thus strengthening the objectivity of the results.

The quantitative data have provided results that are reliable without the element of subjectivity (Day et al., 2008) that can be used to categorise and assess geographic information competencies required for reviewing EIAs.

Chapter 5 presents the results derived from the semi-structured interviews.

Chapter 5:
Interview Results

5.1 Introduction

Like Chapter 4, this chapter addresses the second objective of the research, that is, to ask practitioners at departments concerned with environmental management to assess their perceptions and opinions about the use and value of geographic information in EIA report review and decision-making and about competencies required for this. This chapter presents the results of the interviews. This chapter looks at the interviewees and then presents the guiding questions for the interviews. Then the results are presented, following a narrative approach where some direct quotations are included. With respect to direct quotations, words that might reveal the identity of the interviewees were changed for ethical reasons, for example, by using words with a similar meaning. The detailed responses are attached as annexures. Since the interviews followed a semi-structured approach, additional questions were asked as and when necessary, and there were also some detailed discussions. Therefore the presentation of the results has included the responses to these additional questions and reflects the discussions.

5.1.1 Interviewees

Information about sampling for interviews was provided in Section 3.4.3. This section provides further information about interviewees. There were 21 interviewees. The plan was to interview two officials per competent authority. In one competent authority there was one additional official who volunteered to be available. Hence, 21 interviews were carried out. All interviewees were involved in the review of EIAs at various levels. Some were in middle management positions, meaning they were supervising others, but they still did a large amount of EIA report review activities. Others were at junior levels, doing EIA review on a day-to-day basis. Figure 5-1 shows the number of interviewees per competent authority. Pseudonyms of competent authorities have been used for ethical reasons.

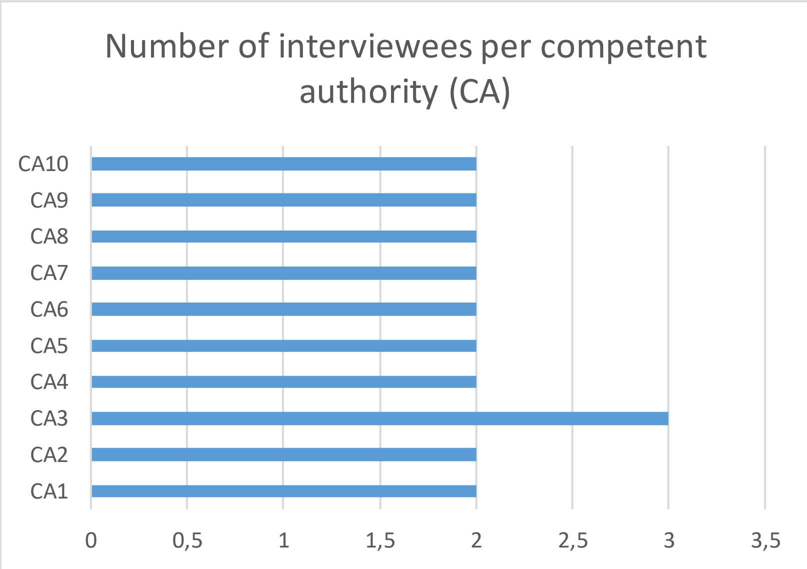


Figure 5-1: Number of interviewees per competent authority (CA)

5.1.2 Guiding questions for the interviews

The guiding questions for the interviews obtained both quantitative data and qualitative data (Annexure 3.3). However, the questions collected mainly qualitative data, unlike those in the survey questionnaire. The results in this chapter present all the outcomes from the interviews. The questionnaire for interviews was designed according to categories (themes). It had three sections.

Section A contained questions about participant information. Section B was the largest section. It contained questions about the use of geographic information in the review of EIAs. These were grouped into four categories. Category 1 had questions about use of geographic information. Category 2 had questions about the value of geographic information. Category 3 had questions to assess understanding of geographic information competencies. Category 4 focused on improvement strategies. Section C was designed for those who were not using geographic information. The guiding questions are summarised in Table 5-1.

Table 5-1: Summary of the guiding questions

Section A: Participant information
Workplaces of participants
Number of years in reviewing EIAs
Qualifications
Level of education and training in GIS and remote sensing
Section B: Use of geographic information in the review of EIAs
Category 1: The use of geographic information
Participants were asked if they use geographic information in EIA report review.
In addition, to state the specific areas in the EIA report review process.
When did they start using it?
They were also asked to mention how do they use it during the EIA report review process.

Category 2: The value of geographic information
How is geographic information helping in EIA report review and decision making?
Mention any challenges encountered.
Category 3: Understanding of geographic information competencies
Participants were requested to share based on their understanding, what it took to be able to use geographic information.
Also, to state geographic information competencies required in order to review EIAs.
Category 4: Improvement strategies
What can be done to encourage the use of geographic information by officials?
How does the legislation deal with the use of geographic information in EIA report review, especially by officials?
Section C: Participants who were not using geographic information
Participants were requested to state the reasons for not using geographic information in EIA report review.
They were also asked if they are interested to learn how to use it.

In the last part of the guiding questionnaire, all participants were asked if they were aware of any academic documents about the use of geographic information in EIA report review and decision making in South Africa and in any other country. If they were aware of such documents, also to let the researcher know how to get hold of them.

5.2 Presentation of interview results

The reporting of the results below follows the same order as the design of the guiding questionnaire.

5.2.1 Section A: Participant information

The first question was about confirming places of work for the interviewees. There are ten competent authorities in environmental impact assessment. Figure 5-1 has already demonstrated that all competent authorities were involved in this research.

Participants ranged from having less than five years to more than 15 years in the field (Question 2).

With respect to the qualifications (Question 3), Figure 5-2 shows that one had a Diploma, six had Bachelor’s degree, two had Bachelor of Technology, the majority (8) of interviewees had an Honours degree, four had a Master’s degree, and none of the participants had a PhD.

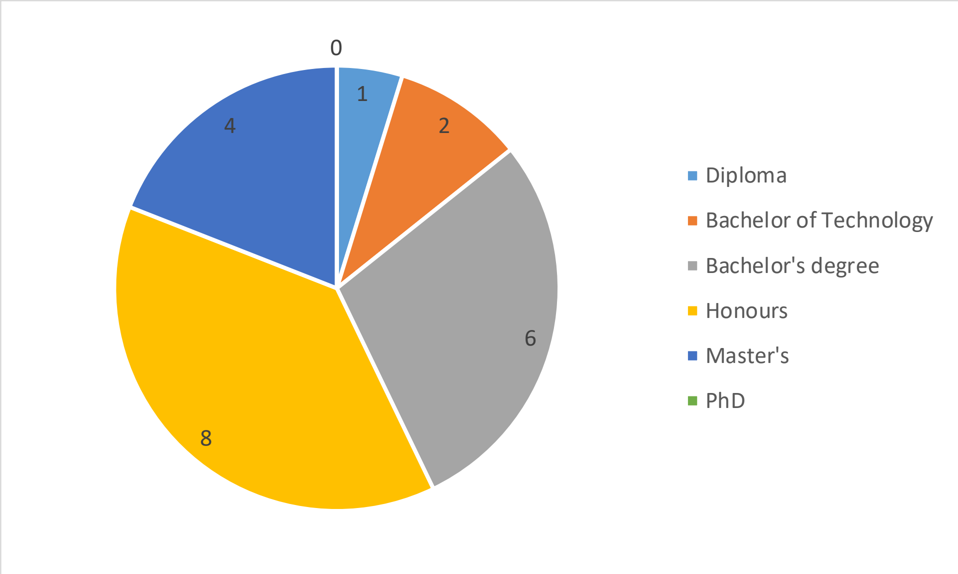


Figure 5-2: Qualifications of interviewees (Question 3)

Since the interviews were semi-structured, the researcher asked some interviewees other questions that were not necessarily part of the questionnaire. Table 5-2 shows the range of specific names and levels of qualifications of interviewees and how many interviewees had that particular qualification.

Table 5-2: Specific qualifications of interviewees

1	Diploma in Nature Conservation
1	Bachelor of Arts (majored in Geography and Psychology)
1	Bachelor of Science in Environmental Sciences
1	Bachelor of Science in Biochemistry
2	Bachelor of Science in Environmental Management
1	Bachelor of Science in Chemistry and Biochemistry
1	Bachelor of Technology in Nature Conservation
1	Bachelor of Technology in Environmental Management
1	Bachelor of Arts Honours in Environmental Management
4	Bachelor of Science Honours in Environmental Science
1	Bachelor of Science Honours in Botany
1	Bachelor of Science Honours in Geography and Environmental Management
1	Bachelor of Science Honours in Environmental Monitoring and Modelling
1	Master's in Environmental Management and Master's in Business Administration

1	Master's in Environmental Resources
1	Master of Laws Degree (LLM)
1	Master of Arts in Geography and Environmental Studies

In Question 4 interviewees were asked to mention any other qualification that might have not been mentioned above. Only one qualification was mentioned, that is, the Environmental Management Inspectors course done at level 7 at UNISA.

In Question 5, interviewees were asked to indicate their level of education and training in GIS. Figure 5-3 shows that seven interviewees had two weeks or less training in GIS. Six did not have any training in GIS. Four interviewees had one or more semester modules in GIS. One had a Bachelor's degree in GIS. No other options were chosen.

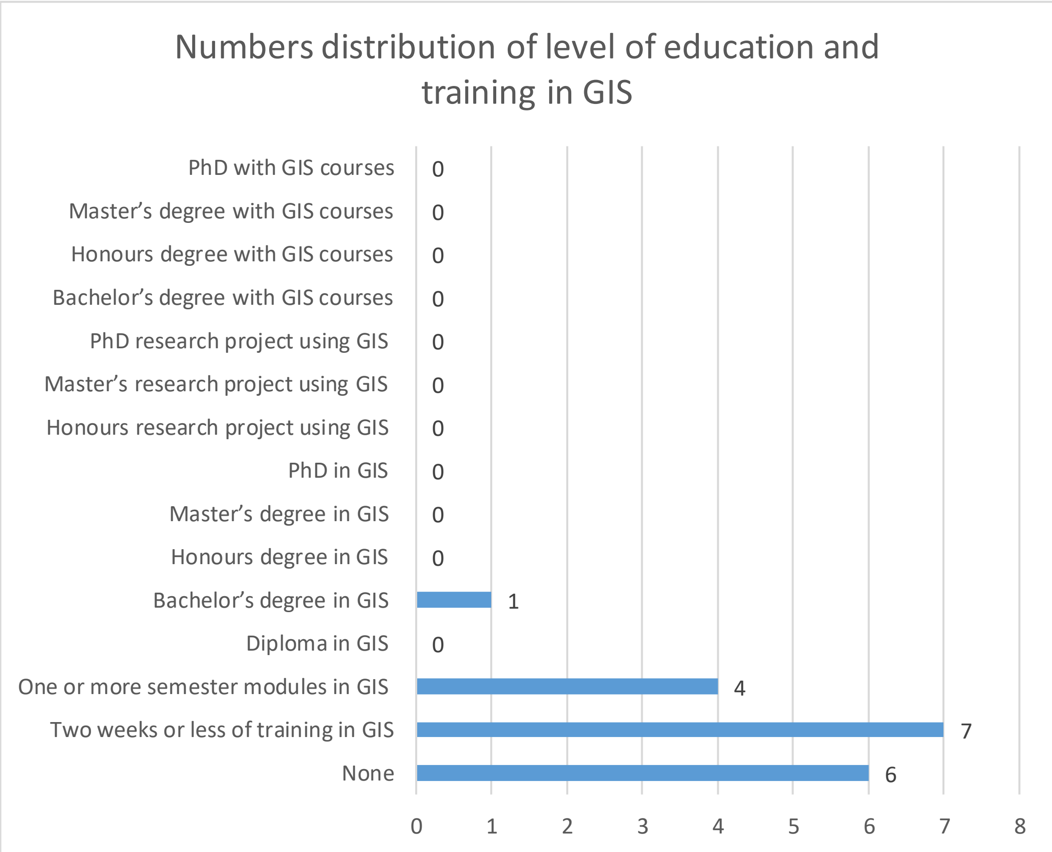


Figure 5-3: Levels of education and training in GIS for interviewees (Question 5)

In Question 6, the focus was on the level of education and training in remote sensing. Figure 5-4 illustrates that 12 participants did not have any training in remote sensing. Two had a

Bachelor's degree. Another two had an Honours degree with remote sensing courses. Three have two weeks or less of training in remote sensing. Many other categories had none.

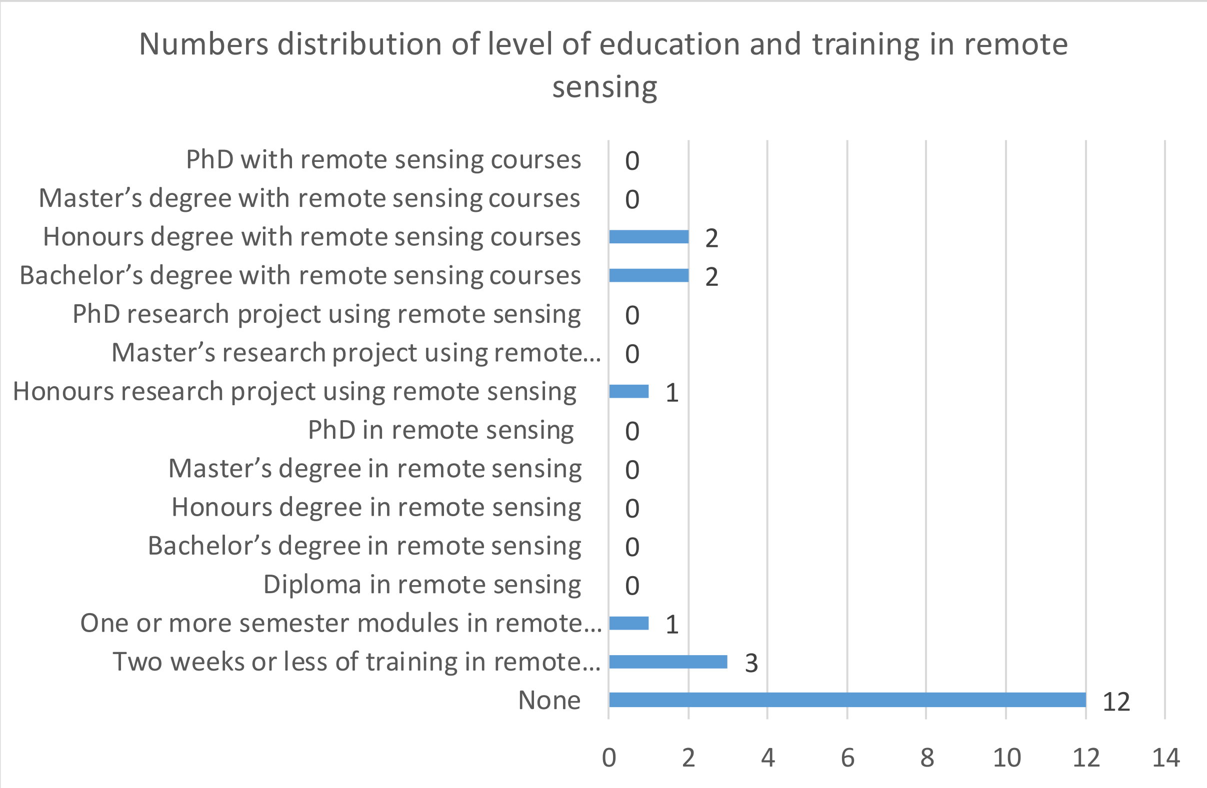


Figure 5-4: Levels of education and training in remote sensing for interviewees (Question 6)

In Question 7 they were asked to mention any other training or qualification related to GIS or remote sensing that might have been omitted. No qualification was mentioned.

In Question 8, interviewees were asked if they felt the need to do more courses in GIS. 19 out of the 21 officials felt that they would like to learn more.

The two who responded that they did not feel the need to do more GIS courses were asked to provide the reason for not wanting to do more courses (Question 9). Interestingly, the two officials were from different competent authorities but provided the same response. They both indicated that their qualifications covered what they needed with respect to their day-to-day work.

In Question 10, those who indicated that they would like to do more courses in GIS were asked to mention at least three courses that they would like to do to function more effectively. Annexure 5.1 is an attempt to categorise knowledge areas from 21 interviewees. This categorisation also assists to make a long list of courses look shorter as 21 interviewees mentioned two to three courses. The knowledge areas mentioned by interviewees as well as some of the direct responses are mentioned below. Further details are in Annexure 5.1.

Introduction to GIS was emphasised by several interviewees in different ways. Other EIA officials wanted to learn just the basics such as how to open a map, map interpretation, how to query, how to find sensitive areas in an application, print a page with sensitive areas or any page of interest, and mail it to the EIA consultant (EAP). About four interviewees mentioned that they would like to learn map interpretation. Interviewees explained that understanding the features of the site was important to determine whether the proposed site was a sensitive area or not.

Interviewees wanted to learn about basic GIS operations. Below is a direct response from an interviewee:

> *"As someone with no GIS education, I would still like to get training on a GIS course that will assist me to identify the current situation on the ground. Identify the amount of biodiversity in the proposed site. That will assist me in making more informed decisions. May be in future it will motivate my interest in doing research and assist with desktop studies."*

Data capturing was another skill that interviewees emphasised, especially in relation to Listing Notice 3 activities. In Listing Notice 3, the listing of activities is based on the geographical area. Some interviewees mentioned that they would want to learn how to use GPS to collect data on a site proposed for development. This would be helpful in cases where one needs to measure the size of the proposed development, as the size determines whether the activity is listed or not, that is, whether the proposed development required environmental authorisation or not.

In relation to Listing Notice 3, another interviewee mentioned:

> *"Although I don't know how GIS works, but we need it for the Listing Notice 3 – we need a GIS tool to assist us to verify activities, to analyse sensitive areas".*

With respect to data analysis, one interviewee stated:

> *"With analysis, you can extrapolate information from data layers, instead of just looking at it."*

Spatial analysis was also mentioned as another knowledge area which is particularly important for EIA reviewers. One interviewee responded:

> *"It would help to have a GIS tool that will assist us to analyse environmental sensitivity of the area for it to be in our exposure and be able to use it to verify the activities, if they indeed are triggering that listed activity because it could be very tricky with all the aspects that come with Listing Notice 3. Like it is difficult to know the ecological status of all the areas that you are working under without the tool being there to be able to assist you."*

Knowledge about databases was important to manipulate data that is in the database. Other interviewees mentioned the need to know how to manage and manipulate data, for example, after collecting data from the site, how to create a database for that particular project. Below is a quotation indicating the yearning to have knowledge about databases:

> *"To capture data in a GIS, to find those records, to keep those records, because the records do somehow get lost in the system if you don't have an organised system. I think GIS can also be able to assist in that manner, although I've really said I don't know how GIS really works but I think if there is anything that GIS can offer in that regard, it could be helpful as well".*

Remote sensing knowledge was also needed as there are now web-based systems.

The second objective of this study was about assessing understanding of the use and value of geographic information in EIAs. Hence Section B, the questions about the use of geographic information in the review of EIAs, was designed to assess this understanding from officials who do EIA report review as their core function.

5.2.2 Section B: For those using Geographic Information

5.2.2.1 Category 1: Use of geographic information

Category 1 included questions about use of geographic information. Figure 5-5 is a depiction of how many participants used geographic information in EIA report review and how many did not use it (Question 11). Nineteen used geographic information in EIAs. Two interviewees specifically said that they do not use geographic information even after they were shown different examples of geographic information in the introductory section of the guiding questions (Annexure 3.3). The reason was that they did not have a clue about GIS and geographic information (refer to Section 5.2.6).

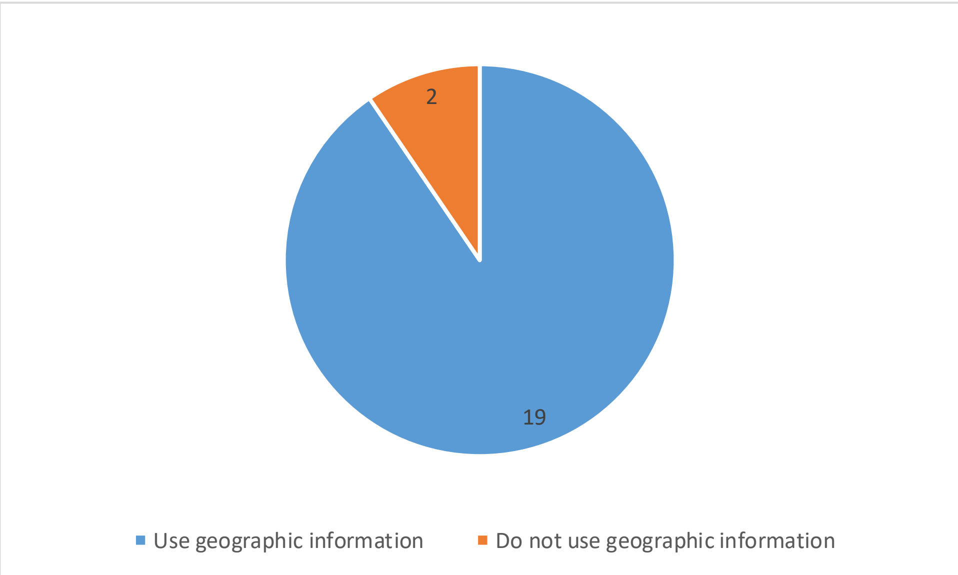


Figure 5-5: Number distribution about use of geographic information by interviewees (Question 11)

Since semi-structured interviews allow additional questions, out of interest, the researcher asked interviewees to provide examples of geographic information they used in reviews. Most interviewees mentioned hard copy maps and biodiversity sector plans (BSPs). Other interviewees, in addition to hard copy maps and BSPs, added other sources of geographic information such as Google Earth, the South African National Biodiversity Institute (SANBI), the Screening Tool developed by DFFE, and cadastral data.

All 19 respondents who indicated that they used geographic information were then asked when they started using it in EIA report review (Question 12). Figure 5-6 is an illustration of when interviewees started using it. Nine indicated they used it from their first year of reviewing EIAs. Ten interviewees indicated that they started using it a couple of years later.

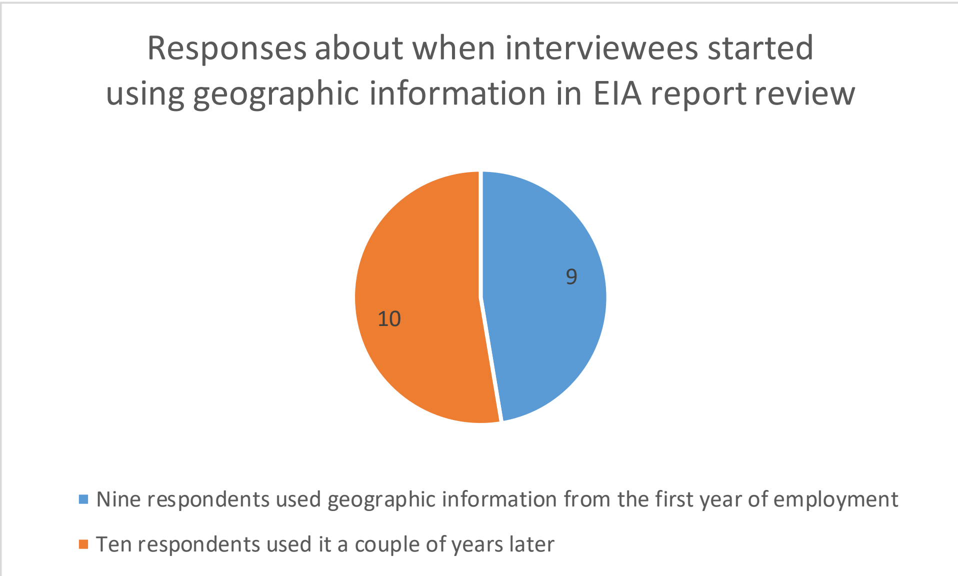


Figure 5-6: Responses about when interviewees started using geographic information in EIA report review (Question 12)

Various reasons about why other officials started using it from their first year of work and others later are included in this section. Interviewees mentioned reasons such as understanding the value of geographic information, qualifications, training in the workplaces, and support or lack of support from their seniors.

In Question 14, interviewees who were using geographic information were then asked what prompted them to start using geographic information. Responses from interviewees show that geographic information assisted in identifying sensitive areas, especially for Listing Notice 3 activities. It is important in preparation for site visits. Direct quotations below indicate that geographic information made the life of EIA reviewers easier:

> *"It is easy to see something in a picture. It is much easier to understand at times. It is easy to use, easy to understand, you can get a very quick indication of the type of sensitive areas and the listed activities. We use it for Listing Notice 3 activities to identify geographical areas as per Listing Notice 3".*

> *"To verify information before going to site".*
>
> *"To find information about features, like rivers, slime dams, dolomite, vegetation, etc."*
>
> *"EIAs are complex that is when you need geographic information".*

Following on from an indication that they were using geographic information, in Question 15 they were then asked in which specific areas in the EIA process they used it. The following specific areas were mentioned by participants. Annexure 5.2 provides the details.

Application stage

After receiving the application, geographic information is used to confirm the location of the site in preparation of site visit. It is used to check site sensitivity. Checking site sensitivity is important in order to determine compatibility of the proposed development with the site. The interviewees explained that the actual review of the content started after checking such information. One of the interesting quotes about why geographic information was used before going to site was:

> *"Going to site visit you see what your eye can see unlike checking the map."*

Geographic information in the application stage was also used in preparation for meetings with applicants and consultants (EAPs). These meetings could be in the office or on site. Geographic information provides information about features of the site, such as biodiversity. It provides the spatial extent of the site. A web-based system is used to get cadastral information. Google Earth is useful to understand the history pattern of the area where there is a proposed development. One interviewee stated:

> *"It gives you nice background. It gives you an aerial view of the areas, then you prepare better, like understanding vegetation, soil, agriculture, etc. All this information helps you to have a fruitful discussion with the applicant or an EAP".*

Another interviewee responded:

> *"Google Earth, satellite photographs are used to check if there isn't any illegal clearance of vegetation".*

Site visit stage

The officials study maps received as part of an application. They compare maps received as part of an application with different data sources such as web-based system, Google Earth, and satellite photographs.

Review stage

When the report, either BAR or S&EIAR, has been received, the EIA official reviews the report with other sources of geographic information such as SANBI, and BSP. This is done for verification purposes, for example vegetation names, and whether the area is protected or not.

Preparation for decision stage

Officials used geographic information to justify their recommendations for a decision:

> *"Also, when you present to the team that makes a decision you show what the map is saying and what is happening on site".*

5.2.2.2 Category 2: Value of geographic information

In Question 16 participants were asked to explain how, ever since they started reviewing EIA reports, geographic information has helped the review and decision-making. What was noted in the responses to question 16 was that it was a repetition to some of their responses to question 15. To avoid repetition in the explanation below, only new information is presented. The detailed responses to question 16 are in Annexure 5.3.

Geographic information provides information that extends beyond the boundaries of the proposed site, for example, biodiversity corridors. In terms of the EIA process, such information is especially important because it assists to determine the nature of the assessment that must be undertaken. Interviewees mentioned that because of the extent of some of the sites it was impossible to walk through the entire site. This was where geographic information has been valuable because it provides the spatial extent of the area. One said:

> *"Access to geographic information helps us to confirm things ourselves. We no longer have to transport files to another office to get comments about site sensitivity. We can see that the proposed site is within or outside the critical biodiversity area. So, we are now able to cut that forty or fifty days of referring the file to another section".*

Other interviewees agreed that geographic information is helpful. However, they were very quick to raise concerns. One interviewee stated:

> *"It is helping to a little extent. Maps do not tell you the site-specific area. It shows you a broad idea".*

Another interviewee stated:

> *"It helps me to confirm what the EAP is saying but it is a challenge because the Biodiversity Sector Plan can say the place is a critical biodiversity area (CBA) when it is no longer a CBA anymore. So, when you go on site it is not what it is on the BSP. So, we also rely on EAPs to get better information from the other commenting authorities".*

In Question 17 interviewees were asked to explain any difficulties or disadvantages they encountered as they used geographic information. Table 5-2 lists some frustrations or struggles encountered by participants with respect to the use of geographic information in EIA report review. Annexure 5.4 provides the details.

Table 5-3: Frustrations encountered by interviewees when using geographic information (Question 17)

Categories	Description / Quotations from the interviewees
IT problems	Network problems. Sometimes the network is slow or not even there. Sometimes the network problem is beyond the GIS technician. Sometimes technicians respond after two days whereas the EIA has timeframes
Time	One example the interviewee provided was the time it takes to geo-tag pictures and create a map and link to your report. The EIA has timeframes that you must meet, so you end up not being able to use those pictures and create a map because it takes time
Lack of resources	Lack of proper computers, access to software. In some cases, there is only one computer with the software and then there is a queue. This is a challenge because EIAs have timeframes
People issues	Concerns about the Senior Manager’s understanding of the value of geographic information
	There is free software that one can download but even for that you need IT permission. It takes time to get that approval
Outdated geographic information	Sometimes you cannot depend on it one hundred percent. Ground-truthing needs to be done in anyway
Lack of other important geographic information important in EIA report review and decision-making	It doesn't really speak to other issues such as socio-economic issues, where one can use the system to inform the aspects such as of need and desirability of a proposal. Because now we've got one leg which is the environmental leg, which represents one of the components of the environment, but clearly there is another leg, the socio-economic component
Lack of technical expertise / knowledge	Inability to interpret the geographic information. Lack of technical expertise
Lack of training	Officials do not have background knowledge about how to use geographic information

Responses indicate that officials used geographic information; however, the frustrations could become a deterrent. The amount of time required to solve some of the IT issues has been a hindrance. Interviewees mentioned that sometimes it takes more than two days for IT people to respond. This causes problems as EIA report review has timeframes.

The amount of time required to perform some of the activities with respect to geographic information has been a challenge given the fact that EIA has time frames. The time it takes to geo-tag pictures and create maps and link to the report to substantiate the decision is a challenge given the EIA timeframes.

Access to necessary resources such as software and high processing computers has been another serious challenge. Interviewees mentioned that most of the time they would be told that these resources are expensive.

There was also a concern about the senior managers' understanding of the value of geographic information. Officials were also told that resources (provision of high-powered computers, data and software) are expensive.

Outdated geographic information was mentioned a number of times. One interview responded:

> *"Sometimes you cannot depend on it 100%. Ground-truthing needs to be done in anyway. If we can reach a stage where we say information is reliable, there you can make a decision that can be fine. We need to get to a stage where it is regularly updated, it is reliable information, like eight percent or ninety percent is reflecting the site as it is."*

Since some of the data sources are outdated and officials have had to find other ways of verifying, such as, using different sources of geographic information. Another interviewee explained that outdated data have caused delays as specialist reports have then been required to make a final decision.

Lack of other important geographic information, which is important in EIA review and decision-making was another difficulty. One interview responded:

> *"It doesn't really speak to other issues such as socio-economic issues, where one can use the system to inform the aspects such as of need and desirability of a proposal. Because now we've got one leg which is the environmental leg, which represents one of the components of the environment, but clearly there is another leg, the socio-economic component."*

Interviewees mentioned a lack of training as one of the main problems or difficulties preventing use of geographic information. It was mentioned that some officials did not have the background knowledge to make use of geographic information. Some officials lacked technical expertise.

5.2.2.3 Category 3: Understanding of geographic information competencies

In Question 18 interviewees were asked to explain their understanding of what it takes to be able to use geographic information in EIA review. Annexure 5.5 provides details.

Interviewees mentioned capacity building through different methods, like training, either formal or informal, workshops, awareness sessions, webinars and information sharing. Interviewees also mentioned knowledge areas or skills that should be covered in the training sessions.

Knowledge about geographic information and GIS was emphasised by interviewees. Knowledge and practice about basic GIS skills such as how to query, produce maps, and send them to the applicant, were mentioned. Analytical skills were particularly important as they teach one the ability to look at the geographic information and question what it means in relation to EIA issues. Training sessions need to provide knowledge of the software types, and officials need to have software on their computers.

In addition to technical knowledge, interviewees mentioned the importance of practice. It was mentioned that:

> *"The more you are exposed to it, the more you are able to use it."*

Legislation is one of the ways that will make officials use geographic information in EIA review. Therefore, the use of geographic information needs to be a requirement in the EIA regulations.

In Question 19, interviewees were asked to explain their understanding of the geographic information competencies required to review an EIA. This question is linked to the second objective, to assess their perception and opinions about the use and value of geographic information in EIA report review and decision-making and about competencies required for this. It is also linked to the fourth objective, to develop a taxonomy of geographic information competencies for environmental impact assessment report review and decision-making.

Responses from interviewees emphasised the need for theoretical knowledge and practical knowledge. Knowledge about maps as part of geography and/or GIS was emphasised. One interviewee stated:

> *"Anything about maps."*

Interviewees were not limited in terms of how many competencies they could mention. Annexure 5.6 has the detailed list. In some cases when the interviewee mentioned a particular competence, the interviewee was asked to elaborate and provide the reasons. As a result, explanations have been provided for some competencies. Some interviewees provided reasons on their own. The information below provides the summary of geographic information competencies required in EIA review.

Some of the specific issues mentioned and why they are important include competence about vegetation classification. One interviewee mentioned that officials need to have knowledge about how to classify the slopes and the vegetation that occurs in that particular area. In EIAs, geographic information should be used to check the appropriate slopes for development. For nature conservation, it would be good as a management tool for burning purposes as geographic information can be used to check which methods to use for burning.

The responses from interviewees made it clear that the course or qualification need to include both environmental management and GISc. For example, in terms of Listing Notice 3, an applicant could be applying for a development (mast or tower, road, resort, or hotel) within a specified geographical area (critical biodiversity area, World Heritage site, and protected area in terms of the National Environmental Management Protected Areas Act (NEMPAA)). Sometimes officials need to determine whether or not the applicant needs an environmental authorisation. Officials need to have technical knowledge and skills about how to use geographic information to make that determination. Officials need to measure the size of the proposed site, check its proximity to the sensitive area, and manage the quality of that data.

Interviewees said this about the course:

> *"It has to be done as early as possible at varsity. So, students can go through the normal module of GIS but they need to have practical side of the tool in the EIA, practical application in the EIA review. That practical aspect needs to come from the university. So there could be a case study that students work on, they look at a particular site, they screen that site to determine the impacts so that when they become practitioners they know this is how the tool is applied."*
>
> *"Anything which goes with maps"*

Interviewees mentioned that these courses can be provided at a diploma or degree level. The need for capacity building was emphasised.

Other related courses such as mathematics, computer skills and IT were mentioned. For example, knowledge about computers and IT was viewed as important because sometimes there are updates that IT officials do in the computers and if one is not familiar with computers, those updates can be confusing.

5.2.2.4 Category 4: Improvement strategies

Category 4 in Section B was about improvement strategies. This category was based on the third study objective, which is to recommend the improvement strategies.

In Question 20, interviewees were asked that given their knowledge of the importance of geographic information in EIAs, what can be done to encourage its use by officials. (Full details are in Annexure 5.7).

Most interviewees mentioned capacity building in different forms, that is, accredited training, short courses, webinars, refresher training, workshops, awareness campaigns, and information sharing.

Training should include information about the benefits of using geographic information to stimulate interest. It should also include practical exercises and basic knowledge of geographic information.

There is a need to encourage officials to attend GIS days. Officials would learn about developments in geographic information and the variety of things that can be done with it. One interviewee had this to say about what he learnt during GIS Open Days organised by DEA:

> *"Because it's not only about maps and drawing up maps but there's so much you can do with it. And the way it has evolved in the last couple of years. Emergency exits from a town are done with GIS. You can design railways, roads with GIS. It's not normal maps anymore with it now. Give people more access, show them, and tell them. It's not just*

about maps. There will be interests. The keynote speaker in the GIS Day showed things that I didn't think GIS can do".

Interviewees also mentioned how training can be done. One interviewee responded by saying:

"Make information sharing a norm."

Interviewees said that senior managers needed to open training opportunities. There was a need to get experts to show the true value of geographic information. Short training sessions could even be done in the office. Such training sessions must cover practical assignments. GIS personnel must train end-users.

Legislative measures were also seen as important to improve the use of geographic information by officials. Another interviewee stated:

"Make the use of geographic information a requirement in the regulations."

Interviewees stated the need to provide resources such as software for each official as opposed to one computer in the whole office. Each computer should have all the geographic information that is required. One interviewee stated:

"It is discouraging to attend the course and you come back to the office there are no resources".

In Question 21, interviewees were requested to explain how well the legislation dealt with the use of geographic information in the EIA review, especially by officials. Officials responded in different ways to the question. Some interviewees stated that the regulations are clear, making reference to regulation eight which instructs officials to provide advice about the EIA process to applicants and EAPs (South Africa, 2014). Other interviewees could not really point to where it was stated in the regulations, but said that in their office they used geographic information because of the screening tool and Listing Notice 3. Other interviewees stated that the regulations focus on EAPs (consultants). Most interviewees stated that the regulations were not clear when it came to the role of officials. Regulations need to be strengthened. Details are provided in Annexure 5.8.

5.2.3 Section C: For those not using Geographic Information

Only two interviewees responded to these questions as they had indicated in question 11 that they did not use geographic information.

In Question 22 they were asked about the reasons or challenges making them to be unable to make use of geographic information in their day-to-day work. Their responses indicated clearly that they lacked the technical knowledge. Interestingly, they came from different competent authorities, but they used the same words:

"I don't have a clue about how to use GIS."

However, they both indicated that they would be interested in knowing more about geographic information (Question 23). They also indicated that would be happy to learn how to use it in the EIA review (Question 24).

All participants were asked if they are aware of any academic documents which have documented the use of geographic information in the review of EIA and decision-making in South Africa or in any other country. Their responses (awareness) are depicted in Figure 5-7. Out of 21 interviewees, only one was aware and 20 were not aware (Figure 5-7). This particular interviewee mentioned the names of the people who might have further information about this issue and referred the researcher to the organisation that might have the document. Annexure 4.3 provides the responses as provided by the survey participants and interviewees.

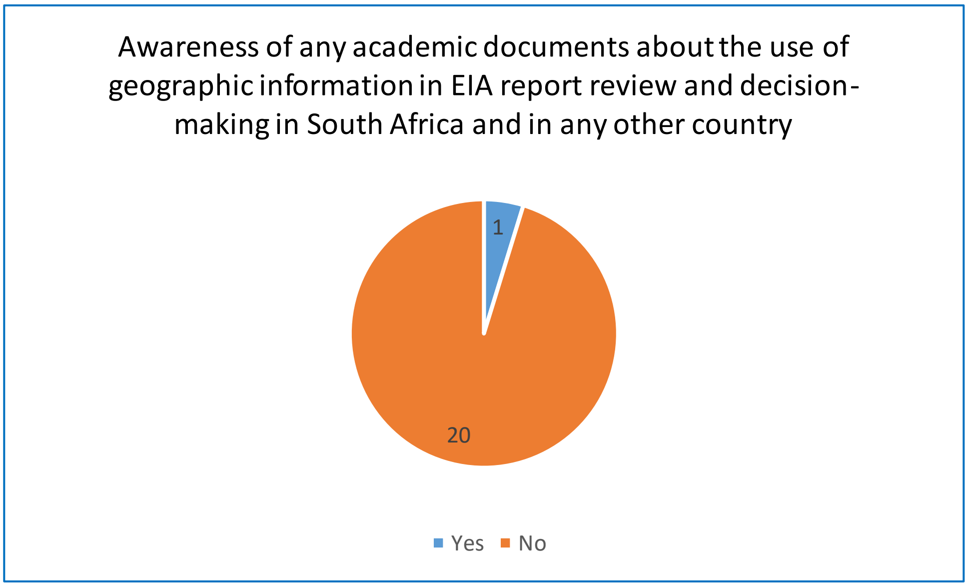


Figure 5-7: Awareness regarding documents about the use of geographic information in the review of EIAs in SA and in other countries (Question 25)

5.3 Conclusion

The results of interviews have shown that the majority of participants, 19 out of 21, used geographic information, either in the form of hard copy maps or Google Earth or GIS map layers. They also indicated in which specific areas in the EIA process geographic information was used.

Interviewees valued geographic information, as shown by the fact that nine interviewees started using it from their very first year of employment. Ten participants explained that it took some time, but they are now using it. This is a clear acknowledgement of the value of geographic information in EIA review work and decision-making. Another indicator of their understanding of the value of geographic information was the list of knowledge areas and skills that they would like to develop in order to function more effectively.

Officials valued geographic information as it assists them in various stages of the EIA review. It has been used, amongst other things, to check site sensitivity, to understand the history pattern of the proposed site, to confirm whether development has commenced on site or not, and to also obtain useful information in preparation for meetings with the applicants (refer to Annexure 5.2).

The interview results about the value of geographic information are important as they help to achieve the second objective, that is, to assess the understanding of the contribution of geographic information at the departments concerned with environment. Through the responses provided, it is concluded that participants understood the value of geographic information in EIA review.

The results also showed that they understood the geographic information competencies required in order to review EIAs. Participants provided a number of geographic information competencies and explained their rationale in relation to the EIA process. Again, this was another significant conclusion as it has addressed the second objective, that is, to assess their perceptions and opinions about the use of geographic information in EIA report review and decision-making and the competencies required for this.

The results obtained included problems that officials experienced as they used geographic information in EIAs. They also provided various improvements methods.

In summary, the interview results provided the information (refer to Annexure 5.6) that the author used to achieve the aim of this research, which to categorise and assess the geographic information competencies required for reviewing EIAs.

Chapter 6 presents the discussion of both the quantitative and qualitative results and draws conclusions.

Chapter 6: Discussion

6.1 Introduction

This chapter addresses the third objective, to analyse and discuss the results of the responses to the questionnaire and semi-structured interviews, and to recommend improvement strategies. Comparison of the results of the interviews with those of the survey as well as similar studies is done in this chapter.

The taxonomy developed by Calkins and Obermeyer (1991) was used as the basis to develop the survey questions for this research. Heifetz et al. (2009) pointed out that taxonomy assists in developing some form of order (Heifetz et al., 2009). Therefore, the design of the guiding questionnaire had sections and sub-sections as explained in Section 5.1.2. However, the analysis and the discussion of the results led into what Teddlie and Tashakkori, (2010) called reconceptualisation of themes. The reconceptualisation follows the order as determined by issues that came out of the analysis. Issues or categories that could be grouped together have been put together for the logical flow of the reporting of the results. Hence the themes in this discussion chapter have been based on what became prominent during the semi-structured interview sessions.

6.2 Discussion of Themes

Section 6.2.1 discusses the use and value of geographic information in EIA report review and decision-making (Theme 1). Section 6.2.2 discusses the understanding of geographic information competencies (Theme 2). Section 6.2.3 discusses the problems and difficulties associated with the use of geographic information in EIA report review and decision-making (Theme 3). Section 6.2.4 discusses improvement strategies (Theme 4). Finally, the value of a taxonomy in surveys and its ability to categorise and classify information is explained (Theme 5).

6.2.1 Theme 1: Use and Value of Geographic Information in EIA Report Review and Decision-Making

> “Applied geography, in the form of maps and spatial information, has served discoveries, planning, cooperation, and conflict for at least 3000 years. Maps are amongst the most beautiful and useful documents of human civilization” (Bolstad, 2008:1).

This quotation and the results of this study demonstrate the significance of geographic information in various applications. The literature review and field data were used to understand the use and value of geographic information. Chapter 2 explained the use and value of geographic information in different applications such as MDGs, SDGs, climate change, planning at a national level, and environmental compliance and enforcement. The results from both the quantitative data and the qualitative data in this research have confirmed the invaluable contribution of geographic information in decision-making. The survey results (refer to Figure 4-5) have shown that that only 5% rarely use geographic information and only 6% never use it. 27% used it daily, 31% used it often and 26% used it sometimes. The high number of interviewees, 19 out of 21, who confirmed that they use geographic information is a significant indication of the value of geographic information in EIA review and decision-making (refer to Figure 5-5).

In addition to the number of users, the results of this research have revealed that geographic information is used for various reasons during the EIA report review. In the survey, EIA officials were provided with different ways in which geographic information could be used. They were requested to indicate on a five-point Likert scale from strongly disagree to strongly agree with the different ways of using geographic information. The survey results revealed that EIA officials agreed strongly with the different ways of using geographic information that were provided (refer to Figure 4-6). Comparing the survey results with the interviews has shown that respondents use and value geographic information. The interview results from question 15 revealed that geographic information has been used from the enquiries stage to the decision phase. It is such information that has influenced the development of the taxonomy of geographic information competencies in Chapter 7. The characteristics that determine the value of geographic information can include, amongst others, who uses geographic information, who benefits from it as well as, what is the purpose of using it (Calkins & Obermeyer, 1991). In this research, applicants, EAPs (environmental consultants), EIA officials, and the competent authority have benefited from the use of geographic information in the EIA process (refer to Figure 4.7). Officials stated how they used geographic information in the various stages of the EIA process (refer to Annexure 5.2).

As it has been reported in Chapter 4, the statistical analysis was carried out to test whether there were any differences in the ways EIA officials responded to the questions such as the need for more GIS courses and their interest in knowing more about geographic information based on the number of years and levels of education in GIS and or remote sensing. The results showed that EIA officials still required more GIS courses. Their responses are not influenced by the number of years reviewing EIAs and levels of education. They were still interested in knowing more about the use of geographic information in EIA report review.

Comparison of the results from the survey and interviews under this theme has provided evidence that officials understand the use and value of geographic information.

6.2.2 Theme 2: Understanding of Geographic Information Competencies

In the EAP qualification standard SAQA ID 61831 (SAQA, 2018), the associated assessment criteria for exit-level outcome 5, that is, review and monitor environmental assessment procedures and methods, mention two competencies, the geographical information science and mapping competencies. This taxonomy expands from the competencies specified in the EAP qualification. Use of technology is also mentioned under critical cross-field outcomes (SAQA, 2018).

The Environmental Assessment Practitioners Association of South Africa (EAPASA), which is the Board for EA practitioners, has not yet accredited any degree programmes (P Sithole, personal communication, 19 March 2021). However, the EAP qualification has been informally introduced in tertiary institutions (R Hill, personal communication, 19 March 2021).

The overview of GIS and GISc education in tertiary institutions (Section 2.10.3) provides context about the results of GISc education and training in this thesis. Literature review revealed that GISc is offered in some disciplines. It makes it easier to understand the results about GIS education as participants have studied for different qualifications, (refer to Table 5-2). Figure 4-3 revealed that out of 15 GIS education and training levels that were provided in the questionnaire, only five were chosen. 30% of participants have two weeks or less training in GIS. The biggest group (42%) have one or more semester module in GIS. 11% have a Bachelor's degree and there is a notable decline as qualifications go higher and higher (6% have Honours and 1% have Master's and none with a PhD).

In addition, during the interviews, the participants with two weeks or less of GIS training, further revealed that they actually did a half-day or one day course organised by the department and delivered either by officials within the department or another invited organisation. Some interviewees with one or more semester module in GIS also revealed that they did it long ago before the GIS developments as they are today.

In this thesis, data were collected specifically from the EAP reviewers. These are officials reviewing EIAs in terms of NEMA section 24C. However, there are similarities with knowledge areas for the GISc community (Coetzee et al., 2014). These skills include data acquisition, cartography, interpretation, mapping, data acquisition, and map reading (Annexure 4.2, 5.1 and 5.6). Mathematics was also mentioned by only interviewee (refer to Annexure 5.6).

The skills were mentioned by survey respondents and interviewees and recorded in the annexures 4.2, 5.1 and 5.6. Some skills and competencies were mentioned repeatedly, such as map reading, interpretation, data acquisition, cartography, spatial analysis, and data manipulation. They came up as responses to different questions in the survey (question 10) and in the semi-structured interviews (questions 10 and 19). In question 12 for the survey, the respondents were requested to rate geographic information competencies. The added advantage with survey results was that ratings of each competence have been presented in percentages (Figure 4-10). In Figure 4-10, just to show some examples, interpretation was rated as particularly important by 81% of participants, followed by map reading at 69%, and then critical thinking at 56%. Percentage ratings give an indication of the importance of that particular knowledge area or skill. This shows the significance of those competencies in EIA review. It also shows the importance of having used mixed methods as this has brought credibility to the results.

GISc practitioners mentioned mathematics and physics, although these knowledge areas were last on the list compared to map reading, interpretation, data acquisition (refer to Figure 2.7) (Coetzee et al., 2014). In this research, only one interviewee mentioned mathematics. Physics was not mentioned by both survey participants and interviewees. It then means that mathematics may not be a core skill, but it is necessary. The literature review and field data from this research have shown that there are certain knowledge areas and skills which are basic or are required by all who perform GIS-related work, unrelatedly of their specific job or sector.

The high rating received by mapping in this study has shown that the following statement about maps still holds:

> "Geography has always been important to humans. Stone age hunters anticipated location of their quarry … by their knowledge of geography, and current societies work and play based on their understanding of who belongs where" (Bolstad, 2008:1).

This quotation shows that geographic information has been important for many years and it remains important today. The responses reported in Chapter 4, is a strong indication that, regardless of respondents' experience and level of education in GIS or remote sensing, they understood the importance of geographic information competencies in EIA decision-making.

Significant similarities of geographic information competencies between GIS professionals and EAP reviewers were observed. Looking forward to Chapter 7, the taxonomy there includes competencies that are relevant to EIA reviewers. Also, in terms of the discussion, it shows the type of content that would be suitable for EAP reviewers. Designing course programmes in a manner that it is more relevant to the EIA reviewers assists in developing the knowledge and skills that will assist EAP reviewers. It also assists the national department and provinces in recruitment processes. It increases the chances of recruiting officials with relevant knowledge and experience for the job.

6.2.3 Theme 3: Problems and disadvantages

> "Geographic information has unique characteristics, and its collection, compilation, and analysis present unique problems" (Kemp and Goodchild, 1991).

This quotation is put here like a preamble to indicate what is to follow. This section discusses the limitations that were encountered.

6.2.3.1 Lack of awareness of spatial data infrastructure and related issues

The level of awareness of important terms (SASDI, SDI, SDI Act No. 54 of 2003) by respondents is concerning. Awareness would help officials to understand that the whole purpose of SDI is to make data accessible within and beyond one organisation. Section 2.7.1 in the literature review explained that government organisations would have a positive impact on SDI developments. Also, if officials are skilled in using geographic information they would also benefit from an SDI because of the data available through the SDI. In this study, one to four percent of survey participants were extremely aware of these terms. Others (35% to 38%) were not at all aware while 36% to 41% were slightly aware (Refer to Figure 4-8).

Improving information sharing would assist to address an issue raised by one interviewee:

> *"I don't think it is about ignorance, I think we need information sharing, training and workshops. People who develop geographic information must train EIA reviewers how to use it. Let's do more information sharing sessions, let's make it a norm. EIA reviewers*

> *must also take it upon themselves to call developers of geographic information / SIM officials."*

The lack of awareness of such important terms could be emanating from the curriculum issues discussed in Section 2.10.3.

There needs to be a better way of sharing information about SDI developments within competent authorities. In addition to the lack of awareness and implications of these terms, participants need to be trained in a number of knowledge areas and skills (refer to Annexures 4.2, 5.1 and 5.6).

The first chapter introduced some of the problems affecting the use of geographic information to be explored in the literature review (Masser et al., 1999; Amade, 2018) and via personal communications. It was indicated that factors such as lack of competence, lack of awareness of the benefits of geographic information, poor communication, lack of funds, lack of management support, and EIA timeframes or the need to comply with the regulated EIA timeframes, all affect the use of geographic information.

Field data collected confirmed what was reported in the literature review. Other studies (Hill and Nel 1996; Maswanganye 2018) also confirmed that the lack of resources affect the use of geographic information and the ability of getting the relevant skills (refer to Section 2.10.3) Field data in Annexure 5.4 records the list of challenges as expressed by interviewees). Lack of resources such as important geographic information for EIA review, outdated data, lack of technical know-how, lack of high-powered computers, EIA timeframes, people issues, as well as associated costs have affected the use of geographic information. In addition to that, access challenges to geographic information have exacerbated the situation (refer to Figure 4-5). In some offices, there was only one GIS computer, and this has been a challenge as officials have to queue to use that computer. Because of the EIA timeframes, officials have ended up not using geographic information because of the time it takes to get access to that one computer.

On the cost implications, some interviewees mentioned that the budget has hindered the provision of resources. This is an example of one quotation regarding why EIA reviewers did not have the necessary software:

> *"Only certain people (GIS personnel) have it. You need permission to get it and it is expensive. When you request software, you are told it is expensive".*

The government has supported GIS developments (Calkins & Obermeyer, 1991; M Moodley, personal communication, 4 June 2020). The results of this study have shown that officials use geographic information, and they are willing to learn more and use it far more than is the current situation. Therefore, the provision of the necessary resources by the DFFE is required as it will enhance the use of geographic information in EIA review and decision-making.

6.2.3.2 Lack of technical expertise

Annexures 4.2 and 5.1 provide a list of knowledge areas and skills that participants would need to function effectively. Annexure 5.6 provides geographic information competencies. In all these annexures, the skill of field data collection was emphasised by respondents in relation to Listing Notice 3 activities as the listing is based on sensitive geographical areas. Respondents felt that field data collection is important in cases where one needs to measure the size of the proposed development, as the size determines whether the proposed development requires environmental authorisation or not and determines whether the activity is listed or not. It is also important to measure the proximity of the proposed development to sensitive areas.

Reviewing the literature about the GIS curriculum and associated challenges made it clear why many participants in this research requested to be trained in various knowledge areas and skills. For example, in the interviews, out of 21 interviewees, only two interviewees stated that they did not need more GIS courses.

6.2.4 Theme 4: Improvement strategies

6.2.4.1 New and improved capacity-building initiatives

In Chapter 2 the literature review explained the importance of competence, linking it with EIA effectiveness studies, achieving goals and objectives of an organisation, NDP aspirations as well as in the context of SDI. With respect to SDI, it emphasised the importance of people in the development and implementation of SDI. Sections 2.7.1 and 6.2.3.1 above have also explained the importance of skills in the SDI context.

Broos (2008) suggested different learning methods following the investigation about the use of technology and challenges by officers from the Netherlands Defence Organisation (NLDO). Learning methods included distance learning, occasional face-to-face meetings, and digital learning modules.

The results of this thesis have aligned with the findings from Broos (2008). The results seen in Figure 4-11 and Annexure 5.7 have revealed that training is highly recommended, but that not everyone enjoys the same training method. Responses showed that officials would like to be trained in different ways, both formally and informally, using webinars, pamphlets, training manuals, and workshops, including field work (Annexure 5.7).

Respondents mentioned knowledge areas and skills should be covered in training sessions. Results in Chapter 4 (refer to Section 4.2 and Annexure 4.2) and in Chapter 5 (refer to Section 5.2 and Annexure 5.1) reveal that officials would like to be trained on various topics such as basics about maps, map interpretation, data analysis, database management, remote sensing, to mention a few. GIS Days already cover these topics (refer to Annexure 6). GIS Days which are held annually in DFFE include topics such as history of maps, GIS applications like in Working for Water programme, Fire control programme, and South African Weather Services; remote sensing; developments in GIS; GIS and National Biodiversity Assessment: the crucial role of spatial data collection, management and analysis; South African National Landcover datasets; the value of GIS. Given the eagerness of participants to be capacitated (refer to Section 5.2.2.3), GIS Open Days will need to be extended to provincial GIS Days. In addition, given the frustrations that officials experience (refer to table 5-3) as a results of the lack of understanding of the value of GIS by Senior Management, it would be important that Senior Managers also attend GIS Open Days.

Given the different forms of training methods that EIA officials listed, it became clear that they were open to other forms of training other than contact sessions or face-to-face training. Therefore, other methods investigated can be used to improve the current method of contact sessions. It was clear that webinars and virtual classrooms, videos and digital learning modules need to be used in addition to contact sessions (Broos, 2008).

Chapter 2 (Section 2.10.3, the overview of GIS and GISc education in tertiary institutions) provided a context for the results of GIS education and training. It revealed that GISc is offered in some disciplines. However, there are endeavours to improve the curriculum (DiBiase, 2008; Du Plessis & Van Niekerk, 2012; Coetzee et al., 2015; Vandenbroucke & Vancauwenberghe, 2016; Maswanganye, 2018). For example, at the University of Pretoria (UP), geospatial technology-related programmes are accredited by the South African Council for Professional and Technical Surveyors (PLATO)[10] (Hodza et al., 2015).

The overview of GISc education has made it easier to understand the results of GIS education as participants had different qualifications (refer to Table 5-2). Figure 4-3 revealed that out of 15 GIS education and training levels that were provided in the questionnaire, only five were chosen. 30 percent of participants had two weeks or less training in GIS education. 42 percent had one or more semester modules in GIS. Eleven percent had a Bachelor's degree in GIS and there was a notable decline in numbers as qualifications went higher and higher as six percent had an Honours and one percent had a Master's and none had a PhD. Similar results were observed in the interviews (Figure 5-3). Seven EIA officials had two weeks or less of GIS training. Four had one or more semester modules. Only one had a Bachelor's degree in GIS. None had higher degrees (Honours to PhD).

The low levels of GIS education (Figures 4-3 and 5-3) as well as remote sensing (Figures 4-4 and 5-4) have provided a clear understanding about the request for more courses in GIS and remote sensing (refer to Annexures 4.2 and 5.1).

During the interviews, those interviewees who stated that they had two weeks or less explained that they actually did a half-day or one-day course organised by their department and delivered either by officials within the department or another invited organisation. Other interviewees who responded by saying that they had had one or more semesters revealed that they did it long time ago before the GIS developments as they are today.

Baker and Wood (1999), Aung et al. (2020), and Morgan 2012) argued that the experience of EIA reviewers as well as capacity building are critical to improve the quality of EIA (refer to Section 2.8.1 of the literature review). EIA officials in this research stated how geographic information helps in the EIA review process. Geographic information assists to identify features of the site to prepare for the pre-application meeting, and helps with site visits to verify information presented in the report (see more details in Annexure 5.2). Therefore, there is a need to strengthen capacity of EIA officials using the methods suggested by participants in this research (refer to Annexure 5.7). Also based on the results of semi-structured

[10] Now known as the South African Geomatics Council (SAGC)

interviews, there was an interest in the GIS open day workshops. This is one quotation from interviewees that shows there is a need for more (refer to Annexure 5.7):

> *"There is a need to encourage officials to attend GIS days. They will learn about developments in geographic information and the variety of things that you can do with it. Because it's not only about maps and drawing up maps but there's so much you can do with it. And the way it has evolved in the last couple of years, people are doing like emergency exits from a search from a town with GIS. You can design railways, roads with GIS, it's not normal maps anymore with it now. Give people more access, show them, and tell them. It's not just about maps. There will be interests. The keynote speaker in the GIS Day, showed things that I didn't think GIS can do."*

The survey results showed that officials would like to be trained on how to use geographic information so that they are able to use it in reviewing EIAs (refer to Figure 4-11). Therefore there is a need for the DFFE to investigate forms of training methods other than the ones currently used. For example, as a UP student, the researcher has observed how UP uses online methods to provide training.

In addition, the statistical analysis showed that regardless of the number of years in reviewing EIAs and level of education and training in GIS and or remote sensing, officials still wanted more training.

Broos (2008) concluded that the availability of technology does not equate to effective use by employees. Broos (2008) added that there is a need for training. Findings in this research revealed the need for improvements in capacity-building activities. Respondents mentioned a number of knowledge areas required. In addition to that, the results made it clear that training was required by those who were already using geographic information as well as those who had not started. The responses indicated clearly that, notwithstanding of respondents' level of education and training in GIS or remote sensing, they still requested more training.

According to the respondent's views, training is one of the key methods to encourage those who have not started using geographic information in their EIA review.

6.2.4.2 Improvements in the curriculum for geospatial technology-related programmes

The amendment of the NEMA in 2004 led to the establishment of the professional body called the Environmental Assessment Practitioners Association of South Africa (EAPASA). EAPASA was appointed in terms of section 24H of NEMA, Act No. 107 of 1998, Government Notice No. 104, as a single registration authority for EAPs. This Association is responsible for, among other issues, the registration of EAPs in line with the EAP qualification standard SAQA ID 61831 (SAQA, 2018).

As was mentioned in Section 2.10.2, currently, the qualification mentions only mapping, GISc and technology, and no further details are provided. Therefore, the results of this study can be used to inform the development of GIS and GISc academic programmes.

Analysing the field data collected through this research showed the need to do exactly what Hill and Nel (1996) recommended. Hill and Nel (1996) recommended the training of professionals up to high level decision makers with respect to GIS and environmental assessments. Participants in this study were eager to know various forms of geographic information. They want training about how to use geographic information, specifically for Listing Notice 3. The listing of activities in Listing Notice 3 is based on sensitive geographical areas. They also expressed the need for senior managers to be familiar with the use and value of geographic information. It will assist in the provision of resources.

The growing interest in the use of geographic information in EIA review is evident from the results of this study. There is a need to know what exactly to teach EAP reviewers so they are better prepared for their profession. This will assist employers not to spend huge amounts of funds on induction and continuous training. Capacity building will always be necessary in EIAs, even more so as technology develops. However, improving the curriculum will alleviate the situation. This is also the case in other studies focusing on the investigation of competencies with respect to GIS knowledge and skills (Doberstein, 2012).

It is therefore important that SDI related topics are included in the curriculum so that awareness of the importance of SDI is created as early as possible. The definitions for SDI in Section 2.6.1 have shown the advantages of SDI. Therefore, by the time people are employed they are aware of the significance of SDI in their day-to-day activities. They will be able to engage in discussions about how to access geographic information they need in EIA review. EIA reviewers are beneficiaries of and contributors to SDI developments.

6.2.4.3 Legislative amendments

The varied responses on the question about how the legislation deals with the use of geographic information by officials indicated that legislation needs to be refined further. Cumulatively more than sixty percent of survey participants (Figure 4-12) indicated that the legislation does not give guidance to officials about how to use geographic information in EIA report review and decision-making. According to the majority of interviewees, currently the legislation is clearer on the side of the environmental consultant than on the side of EIA reviewers (Annexure 5.8).

Strengthening the legislation with respect to the use of geographic information in EIA review should be possible. Table 2-2 shows the number of times the EIA regulations have been amended. In addition to that, responses from participants made it clear that there is a need for clarity on this matter.

6.2.4.4 Continuous initiatives to make geographic information available

In Section 2.6.2 it was explained that in some cases geographic information has been limited for reporting on some SDG indicators. Therefore, mapping of environmental authorisations is another area of obtaining geographic information, thus contributing to the reporting on SDGs and ultimately sustainable development. According to M Moodley (personal communication, 4 June 2020), the mapping of environmental authorisations for renewable energy applications has only started in the DFFE. There are still discussions about the rest of the EAs for other applications (D Marais personal communication, 4 June 2020). Given the significance of this project (mapping of environmental authorisation) in the context of sustainable development and reporting on SDGs, the DFFE needs to devote more resources to it.

As suggested by Scott and Rajabifard 2017 (refer to Section 2.6.2), there is a need for collaboration between national, provinces, parastatals and many other organisations that might have relevant geographic information and skills to deliver on this very important task. Partnerships could also assist in alleviating the costs associated with obtaining geographic information.

The results indicate that geographic information is available and the DFFE continues to make it more available. The results also revealed that there have been some challenges with respect to accessibility. Currently there is a process to make geographic information even more easily accessible. According to M Moodley (personal communication, 4 June 2020), the national department provides data. Where information is not readily available, the DFFE tries to procure geographic information either by purchasing it or obtaining it free of charge from other data custodians. An example is the launch of the 2020 South African National Land Cover dataset. The launch was held on 29 June 2021. The data have been procured and are available on the DFFE's website. More details about more datasets are available on the website (Z Oumar, personal communication, 30 June 2021). Dr Oumar is one of the senior officials in the Spatial Information Management Directorate in the DFFE. He is also a registered Chief GISc Professional.

The level of the desire to access geographic information in a single system expressed by respondents in this study has shown the need for the national department and provinces to continue with efforts to procure geographic information. A response by one interviewee (Annexure 5.4) was:

> *"If we can reach a stage where we say information is reliable, there you can make a decision that can be fine. We need to get to a stage where it is regularly updated, it is reliable information, like eighty percent or ninety percent is reflecting the site as it is".*

The results of this academic study have revealed that officials use and value geographic information, although not at the optimal level because of various issues. There are GIS systems already developed. Training is already being conducted. Geographic information is provided. Even where it is not readily available, endeavours are made to avail it either by purchasing it from service providers or source it free of charge from other government departments (M Moodley, personal communication, 4 June 2020).

6.2.5 Theme 5: Contribution of taxonomy in achieving the research aim and objectives

The taxonomy approach made data analysis easier following certain categories. After collection, data need to be analysed. With qualitative data, thematic analysis and coding needed to be done to structure the data and impose some order. The advantage of using taxonomy to structure the questionnaire was that the themes already existed and data, once collected, could be allocated to those categories. Therefore this research has contributed to the purpose of Calkins and Obermeyer (1991). The taxonomy approach has been found invaluable to source and structure data in an organised manner.

6.3 Conclusion

The analysis of all the results informed the development of the taxonomy of geographic information competencies to be presented in Chapter 7.

The results demonstrated the complementarity nature of a mixed-methods research approach. This discussion chapter has used results from the survey (quantitative data) to augment the findings of interviews (qualitative data), and vice versa. Challenges raised during field data collection showed that limitations to the use of geographic information have been a result of interlinked challenges. Therefore, addressing challenges requires a systematic approach. A one-size-fits-all approach is certainly not a solution (Hodza et al., 2015).

Implementation of capacity building initiatives suggested throughout this thesis will contribute to EIA effectiveness and the quality of EIA reports. The study has also demonstrated how geographic information is used in the EIA review process. This study has also shown that participants use geographic information, although not at an optimum level because of various challenges. As a result, this study has contributed new and improved methods of capacity-building initiatives for EIA reviewers (refer to Section 6.2.4.1).

The results are of relevance to employers. It is the problems and disadvantages reported in this chapter that senior managers need to appreciate so that they can open up a space for induction training and continuous training, and provide the necessary resources for the use of geographic information in EIA report review.

This chapter has also shown the contribution of taxonomy in surveys and its ability to categorise and classify information as the discussion of the results in this chapter is presented in themes. The next chapter looks more closely at the taxonomy of geographic information competencies.

Chapter 7:
Taxonomy of Geographic Information Competencies

7.1 Introduction

This chapter addresses the fourth objective of this research, that is, to develop a taxonomy of geographic information competencies for EIA report review and decision-making which assisted in achieving the aim of this research by categorising geographic information competencies required into six domains of competence and 24 competencies.

This chapter begins by explaining the purpose of the taxonomy for geographic information competencies. Section 7.3 explains how the taxonomy of geographic information competencies was developed. Section 7.4 presents the taxonomy of geographic information competencies in a narrative format. This chapter provides the main contribution of this thesis as related work in Section 2.10.1 showed that geographic information competencies have been developed for various professions, however there is still a need to describe geographic information competencies for officials reviewing EIAs.

7.2 The Purpose of the Taxonomy for Geographic Information Competencies

The purpose of the taxonomy has been to categorise and structure the list of geographic information competencies received during field data collection into domains of competence or what can be called a competency framework, and then, within each domain of competence, list specific competencies.

This section explains the process used to develop the taxonomy for geographic information competencies. Parts of the journal paper, To*wards a task taxonomy for geographic information in decision-making for environmental management the taxonomy'* are based on this section (Hlela et al., undated).

Greenberg (1987), Tory and Moller (2004), Nickerson et al. (2013), and Riggs and Gordon (2017) all revealed that classification is flexible. It is not ready-made. There is no single definite method. The common elements indicate that it is a complex process to develop a taxonomy (Nickerson et al., 2010). As a result, one should not expect to develop the 'best' taxonomy, more so in information systems as they change as new information develops. What is important is that the taxonomy meets the purpose at hand and that the purpose is clearly defined so that it can shape the structure of the taxonomy. Figure 7-1 shows various information taken into account in developing the taxonomy presented in Section 7.4. One should take care not to end up in a never-ending analysis-paralysis situation (Cooper, 2003; 2016).

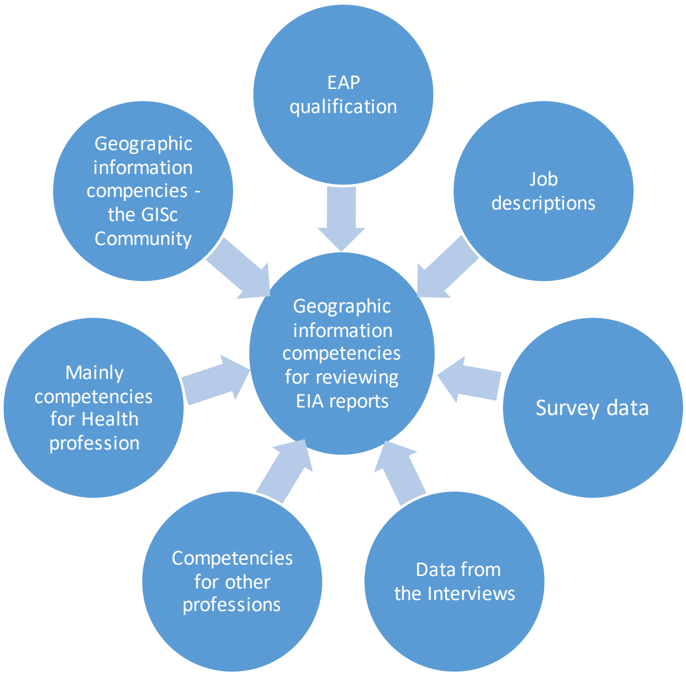


Figure 7-1: Various information taken into account in developing the taxonomy

7.3 Taxonomy Development Process

There is no 'perfect taxonomy' (Cooper, 2003; Tory & Moller, 2004; Cooper, 2016). Given the different types of taxonomies, even an expert taxonomist should not expect to develop a perfect taxonomy. Hence there should not be an expectation of a faultless taxonomy. This element of taxonomy development assists in allaying fears one may have about designing a taxonomy.

From the review of different taxonomy studies, it is clear that developing a taxonomy does require a level of skill and intuition from the researcher. It requires an ability to design a taxonomy in a particular way as long as one can justify the design decisions. The design is influenced by key elements such as subjectivity and the researcher's ingenuity and creativity (Simpson 1961; Fiedler et al., 1996; Leem et al., 2004; Aviezinis et al., 2007; Nickerson et al., 2013).

Parts of the journal paper under review titled '*Towards a task taxonomy for geographic information in decision-making for environmental management*' (refer to Section 1.5) are based on this section (Hlela et al., undated). The common elements of taxonomy development guided the development of the taxonomy for geographic information competencies. It was decided to follow an empiricist inductive approach by collecting data about the current use of geographic information through online surveys and semi-structured interviews. The information in the literature review assisted in understanding and categorising the geographic information competencies mentioned by respondents in this study. The list of geographic information competencies is in Table 3-1 and Annexure 5.6. Given the subjective nature of taxonomy development, the author acknowledges that the taxonomy has been shaped by personal taste, creativity and ingenuity.

The rigorous application of mixed methods approach was used to remove the bias associated with a taxonomy approach. The competencies rated as very important by survey participants were the understanding and interpretation of geographic information, the processing of geographic information, some form of basic training in GIS in order to make use of Listing Notice 3 maps in terms of EIA regulations, map reading, critical thinking, analytical thinking, and familiarity with GIS tools. Taxonomies are presented in different structures. The taxonomy of geographic information competencies is presented in a narrative form.

Chapter 3, the method chapter (Sections 3.4 and 3.5), explained in detail how the analysis was done from the first competency list that was provided by participants to the taxonomy as presented in Section 7.4. In summary, findings from the literature review and personal communications were used to categorise the list of competencies.

The analysis led to the development of six domains of competence: geography, environmental science, GIS software knowledge, field work expertise, critical thinking and related courses. Within each domain of competence there is a sub-set competencies which makes a list of 24 competencies. The terms domains of competence and competency list have been defined as follows:

> "Domains of competence: Broad distinguishable areas of competence that in the aggregate constitute a general descriptive framework for a profession. Competency list: The delineation of the specific competencies within a competency framework" (Englander et al., 2013:1089).

Section 3.4.2 explained how the list of competencies was developed. In addition to Section 3.4.2, there was a specific question in both the survey questionnaire and in the guiding questions. In the survey questionnaire, participants were asked, in your understanding, what are the geographic information competencies that are required in order to review EIAs? They were requested to rate the options provided using a five-point rating scale (from very important to not important). Refer to Question 10 in Annexure 3.4. In the guiding questions (Question 19 in Annexure 3.3), they were asked to share based on their understanding, what are the geographic information competencies that are required in order to review EIAs? The skills specifically mentioned in Section 7.4 are also seen in response to question 10. In Question 10 they were asked to provide at least three knowledge areas or skills they would like to improve on, in order to function more effectively. This confirms the importance of this list of competencies as really the important set of geographic information competencies for EIA officials reviewing EIAs.

The categorisation of the list of competencies took into account that the responses from participants included a combination of theory and practical knowledge. Responses also reflected the importance of a combination of knowledge and skills from environmental science, GISc and related courses that EIA officials need to have in order to perform their EIA report review work effectively.

The taxonomy should be revised when new types of geographic information (e.g. LiDAR), visualisations (e.g. 3D models, augmented reality) or ways of interacting with the geographic information (e.g. virtual reality) become more common in decision-making for environmental management.

7.4 Taxonomy of Geographic Information Competencies

The taxonomy that was developed is presented in a narrative form.

Taxonomy of Geographic Information Competencies

1. Geography
1.1 Map reading
1.2 Interpretation
2. Environmental science
2.1 EIA competence
2.2 Ecology
3. GIS knowledge (Introduction to GIS)
3.1 GIS theory
3.2 Practical application of GIS tool in EIA report review
3.3 How to collect different layers relevant for EIA report review
3.4 Map reading
3.5 Interpretation of geographic information (GIS and remote sensing images)
3.6 Data acquisition
3.7 Vegetation classification - to classify the slopes and vegetation that occurs in that particular place. In EIA, geographic information should be used to check the appropriate slopes for development. For nature conservation, it will be good as a management tool for burning purposes. It can be used to decide on the methods to use, for example, either a helicopter or people depending on the slope of a particular area.
3.8 Spatial data analysis
3.9 Map production
3.10 Database management
4. Field work
4.1 How to view different layers
4.2 How to identify features
4.3 How to draw measurements
4.4 How to draw boundaries
4.5 How to use GIS tools in the field
4.6 How to collect data using GPS
4.7 Digitising
5. Critical thinking skills
6. Knowledge about other related courses
6.1 Basic computers skills
6.2 Mathematics
6.3 IT

7.5 Significance of the Taxonomy of Geographic Information Competencies

This is the first geographic information competencies model in EIA report review. It expands the current list in the EAP qualification by first categorising geographic information competencies into six domains of competence and within each domain, there is a sub-set of competencies forming a list of 24 competencies.

There is a need to improve the quality of EIA report review by focusing on improving the qualifications and training in South Africa (Sandham et al., 2013). This thesis contributes to the capacity building of EIA officials. One of the ways of addressing EIA effectiveness is to conduct multi-disciplinary research (Morrison-Saunders & Retief, 2015). The taxonomy presented in this chapter demonstrates the combination of the different disciplines, GISc, Geography and Environmental Management.

Development of competencies is significant work as models for competencies are used in different ways. DiBiase et al. (2007), Coetzee et al. (2014), Du Plessis and Van Niekerk (2014), and Wallentin et al. (2015) have revealed that competencies can be used in different ways such as to guide training, guide certification and accreditation, and to inform recruitment processes.

Therefore, geographic information competencies developed in this thesis can be used to guide the development of training sessions conducted by the national department and provincial environmental departments to ensure that geographic information is used effectively in reviewing EIAs. They may also be used to guide the development of job descriptions and recruitment processes. Currently, in all the job descriptions assessed while developing this taxonomy, none had this list. Instead, in one job description, there was a request to learn how to use GPS. This request to learn how to use the GPS shows that some officials acknowledge the value of using geographic information in reviewing EIAs. Finally, these geographic information competencies may be used to guide further development of the EAP qualification and accreditation. There are also lessons to learn from the GI-N2K for the EAP profession. Geographic information competencies developed in this research can also be improved by lessons learnt from GI-N2K project and the South African GISc community survey (refer to Sections 2.10.1, 2.10.3 and 8.6).

7.6 Conclusion

This chapter has presented the taxonomy of geographic information competencies for reviewing EIAs. This is the main contribution of this thesis, as according to the literature review, in Section 2.10.1 the categorisation of the geographic information competencies for EAPs reviewing EIAs has not been undertaken to date.

The taxonomy presented in Section 7.4 presents work that sets apart EAPs reviewing EIAs from other professionals. It has been observed that there are significant similarities in geographic information competencies for EIA reviewers with the GISc community. However, the difference is that the description of geographic information competencies in the taxonomy was based on the EIA report review work, as specified by the participants. Also, GISc practitioners included physics as one of the knowledge areas for their profession. Physics was not mentioned by EIA officials.

This chapter has demonstrated the contribution of common elements in the taxonomy development process. The taxonomy of geographic information competencies for reviewing EIAs (Sections 3.4 and 3.5) was guided by the common elements for developing a taxonomy. Parts of the journal paper titled '*Towards a task taxonomy for geographic information in decision-making for environmental management*' (refer to Section 1.5) are based on this section.

The next chapter concludes this thesis by summarising the main results and presents recommendations for further research.

Chapter 8:
Conclusion

8.1 Introduction

This thesis has been the first academic work that led to description and categorisation of geographic information competencies required for environmental impact assessment report review and decision-making, based on literature and on the perceptions and opinions of EIA officials. This last chapter presents the main results of the thesis and suggests future research areas. It addresses the last objective of the research which is to draw conclusions and make recommendations based on the results.

8.2 Summary of the Results of this Thesis

Objective 1: To conduct a literature review on topics that will inform the research, including the use and value of geographic information in decision-making for environmental impact assessments, related work on geographic information competencies and competence management, and the value of taxonomies to categorise and classify information.

The literature was used to explain the significance of geographic information drawing on various applications (refer to Section 2.6). The literature review was also used to indicate the effects of the lack of geographic information. Chapter 1 and Chapter 2 mentioned various reasons for the lack of use of geographic information. The focus of this research was on competence. The literature review was also used to source information about the significance of competence in the context of SDI.

It was explained in Chapter 2 that competence management includes all purposeful actions or undertakings which promote or develop competencies required by an organisation. Given this understanding of competence, this study has contributed to competence management in the field of environmental assessment practice. Chapter 2 also explained how geographic information competencies contributes to EIA effectiveness. Knowledge and skills in geographic information competencies enhance the review of EIA reports by EIA officials. Hence it is important that new ways of capacity building as mentioned by participants are implemented.

Taxonomy was chosen as the method to assess use and value of geographic information in EIA review and decision-making.

The improvement strategies as presented in Chapter 6 were informed by the literature review and field data.

Objective 2: To distribute a questionnaire and conduct interviews with practitioners at departments concerned with environmental management to assess their perceptions and opinions about the use and value of geographic information in EIA report review and decision-making and about competencies required for this.

The research questionnaire and guiding questions were adopted and adapted from the journal paper titled *'Taxonomy for surveying the use and value of geographical information'* (Calkins & Obermeyer, 1991). Their taxonomy assisted greatly in developing the guiding questions for the semi-structured interviews (refer to Annexure 3.3) and survey questionnaire (refer to Annexure 3.4). It was found to be an invaluable tool that created order and helped to organise data into logical categories. This order was especially important during data analysis. During data analysis, the researcher did not have to sift through loads of data to create order. Therefore, the taxonomy approach was found to be a very useful method to collect data and structure it in an organised manner.

Participants in this study understood the use and value of geographic information. They might not have been using it at an optimal level, but the majority used it and they realised its value. Even those who were not using it at all still acknowledged the value of geographic information (refer to Section 6.2.1).

Data were collected using surveys and interviews. For the surveys, various indicators were used to assess the use and value of geographic information. These were interests in acquiring more knowledge, how geographic information has been used in various stages of the EIA process, and role-players in the EIA process who benefit from the use of geographic information.

For the interviews, indicators that were used included the indication of when the interviewee started using geographic information from his or her year of employment, in which stages of the EIA review process geographic information was used, interest to learn more, and a list of knowledge areas and skills that they would like to have in order to function more effectively.

The results of interviews showed that the majority of participants use geographic information, either in the form of hard copy maps or Google Earth or GIS map layers, or sector plan maps like conservation plans. They also indicated how geographic information has been used in the different stages of the EIA report review process (refer to Section 5.2.2 and Annexure 5.2).

This study also revealed that inasmuch as there were all these positive indicators about the use and value of geographic information, there were also challenges having an impact on its use (refer to Section 5.2.2.2 and Annexure 5.4). These challenges included lack of resources such as high-powered computers, access to software, lack of access to geographic information; outdated geographic information, lack of geographic information that is relevant in the EIA process, IT challenges, lack of training, and lack of technical expertise. Other challenges were classified as people issues. These challenges included the lack of senior managers' understanding of the value of geographic information, lack of funds to provide resources, and long procedures to get approval.

Areas of concern included the level of awareness of important terms such as SASDI, SDI, and SDI Act. There was a noticeable low level of awareness of these important terms given the importance of people in SASDI or SDI developments (see Figure 4-8).

With respect to legislation and the use of geographic information in EIA review, the findings revealed that legislation has provided better direction to EAP consultants compared to EIA officials.

The results from both the survey and the interviews showed officials' understanding of geographic information competencies clearly (refer to Figure 4-10, Section 5.2.2.3 and Annexure 5.6). The competencies rated as very important were the understanding and interpretation of geographic information, the processing of geographic information, some form of basic training in GIS in order to make use of Listing Notice 3 maps in terms of EIA regulations, map reading, critical thinking, analytical thinking, and familiarity with GIS tools.

Interview respondents provided a list of geographic information competencies (refer to Table 3-1 and Annexure 5.6). The geographic information competencies mentioned the most included map reading, interpretation, data acquisition, cartography, spatial analysis, and data manipulation. The same competencies were mentioned when interview respondents were asked about the knowledge areas and skills they required to function more effectively. The same set of competencies and skills appeared in the survey results (refer to Annexures 4.2, 5.1 and 5.6). This shows the significance of these geographic information competencies in EIA report review. Furthermore, the percentage distribution in the survey provided a clear indication of the importance of these geographic information competencies (refer to Figure 4-10).

Objective 3: To analyse and discuss the results of the responses to the questionnaire and interviews, and to recommend improvement strategies.

The discussion of the results was in Chapter 6. The main conclusions were, firstly, that the results of this study from both primary data and secondary data have demonstrated the invaluable contribution of geographic information in decision-making for environmental management. Secondly, the field data showed that officials have been using geographic information, even though not at the level as they would have wished, because of various challenges. Thirdly, it has been seen that officials understand geographic information competencies that are required in the review of EIAs and decision-making. The listing of geographic information competencies by officials has also been a clear indication of how much officials value the use of geographic information in EIA review. Finally, it has been demonstrated that taxonomy is an invaluable tool in terms of structuring data and providing order.

Objective 4: Based on the results and informed by literature, develop a taxonomy of geographic information competencies for environmental impact assessment report review and decision-making.

The taxonomy of geographic information competencies for reviewing EIAs has been developed with the purpose of categorising and structuring the list of geographic information competencies in EIA report review. It has been significant as it can be used in a number of ways, including to guide capacity development initiatives, and to guide the development of job descriptions and recruitment of EIA officials in the departments concerned with environmental management. The taxonomy can also guide further development of the EAP qualification and accreditation.

8.3 Contributions to Scientific Research

This research has made many contributions to scientific research. Besides the taxonomy, it has added to the knowledge base in a number of ways, as well as spoken to the competencies required for carrying out various tasks.

A Taxonomy of Geographic Information Competencies

This contribution relates to the aim of this research which was to describe and categorise geographic information competencies required in reviewing EIAs. This thesis has added new knowledge in the discipline of impact assessment by categorising geographic information competencies required in EIA report review (refer to Chapter 7). It has contributed by assessing these competencies in the national environmental department and nine provincial departments of environmental affairs across South Africa. This is the first taxonomy for geographic information competencies in reviewing EIAs. Related work in Section 2.10 showed that significant work has been done to develop geographic information competencies for the GISc community. However, the description of geographic information competencies for EIA reviewers has not been clear. The current qualification for EAPs (South African Qualifications Authority ID 61831) mentions mapping, GISs and technology (SAQA, 2018). Geography competencies required in the environmental assessment state geographic information competencies include map compilation and reading, aerial photo interpretation and GIS usage (refer to Section 2.10.1). This thesis expands on the existing work by categorising geographic information competencies into six domains of competence and a list of 24 different geographic information competencies.

Knowledge Areas and Skills Required in the Environment Sector in Relation to GISc

The EAP qualification standard SAQA ID 61831 mentions GIS but it does not elaborate on specific details about the knowledge areas. Therefore these knowledge areas and skills from this study can be used to design GISc programmes specifically for the environment sector or to design GISc skills in the EAP programmes.

New Knowledge that Sets Apart EAPs Reviewing EIAs

This thesis has contributed new knowledge that sets apart EAPs reviewing EIAs from other related professions, while also showing the relationships within its GISc community (refer to Section 6.2.2 and Chapter 7). The geographic information competencies for EIA reviewers have significant similarities to those of the GISc community. However, the geographic information competencies in Chapter 7 relate to EIA report review. The description of geographic information competencies in Chapter 7 were developed based on the EIA report review work as specified by EIA officials.

A Database of Perceptions and Opinions of EIA Officials

The results of the survey and interviews with EIA officials from the national department of environment, that is, the Department of Forestry, Fisheries and the Environment, and provinces constitute an important database of perceptions and opinions of officials reviewing EIAs (refer to Chapter 4 and Chapter 5).

Documents the Use of Geographic Information in EIA Report Review

This thesis has contributed knowledge in the use (Section 5.2.2) and value (Annexure 5.2.3) of geographic information in decision-making for EIA report review and decision-making. Field data collected through this research have shown the value of geographic information in the various stages of the EIA process as specified by the interview respondents (Annexure 5.2) and the competencies required for this (Annexure 5.6).

Furthers Scientific Research about the Value of Geographic Information and Development of Geographic Information Competencies

Linked with the above contribution, this thesis echoes the recommendations of other researchers in the field of GISc about the need for more research on geographic information competencies from other sectors and professions. Section 2.10.1 has shown that geographic information competencies have been developed for various professionals. This research has provided geographic information competencies for EIA regulators.

Competence Management Needs to be Addressed Using Different Methods

This thesis has shown that competence management (refer to Section 2.8) can be addressed in different ways. The use of the taxonomy for geographic information (refer to Chapter 7) to guide GISc curricula shows that other competence concerns need to be addressed at an academic level. The use of geographic information competencies to guide capacity-building initiatives, job descriptions and recruitment processes shows that other competence concerns need to be addressed in the workplaces.

New Ways of Capacity Building

New ways of capacity building which were not used by the DFFE in EIA training sessions,[11] such as webinars, virtual classrooms, videos, digital learning modules (refer to Section 6.2.4) have been revealed through literature review and data collection. For geographic information to be used optimally in an organisation, there is a need to explore new capacity-building methods.

8.4 Significance of the Research

The findings of this research can be used to:

a) Guide new capacity-building initiatives to ensure that geographic information is used more effectively in reviewing EIA reports that are submitted and on which the decision is mainly based, thus contributing to EIA effectiveness, the quality of the EIA reports, and sustainable development goals.

[11] This was before the start of data collection, which happened from November 2019 to March 2020 and the restrictions due to COVID-19

b) Promote development of focused training to address specific competency requirements.

c) Promote awareness and discussions about possibilities and benefits of geographic information with all role-players in impact assessment. Refer to Section 1.1, Section 2.5, and Section 2.6.6.

d) Provide a better understanding of the importance of competence of officials in the context of SDI (refer to Section 2.7.1 and Section 6.2.3.1) and EIA effectiveness (refer to Section 2.8.1).

e) Guide further development of the EAP qualification and accreditation as the competency models for other sectors have been used in a similar manner (refer to Section 2.10.1).

f) Guide the development of the job description and the recruitment process (also refer to Section 2.10.1).

The recommendations of this study have been based on the results from participants in the DFFE and nine provincial departments of environmental affairs. However, the researcher believes that other EIA regulators can adopt and adapt these recommendations within their organisations. The recommendations can also be used internationally.

8.5 Conclusions

In conclusion, as a result of the importance of geographic information with respect to EIA effectiveness and quality on environmental assessments, reporting on SDG indicators as well as the importance of competence in the implementation of SASDI and SDI, there is a need to explore new ways of capacity-building so that geographic information is used optimally.

Participants have shown that they value geographic information. Therefore, there is a need for continuous endeavours to make geographic information available to all users.

The analysis of the field data has indicated that participants have different interpretations with respect to the legislation in the use of geographic information in EIA report review. Therefore, legislation needs to be amended to provide clear guidance about the use of geographic information by EIA regulators.

Geographic information competencies developed for other professionals are significant in various ways including guiding curricula, accreditation, registration bodies and training initiatives. The geographic information competencies developed in this research can be used in a similar manner.

8.6 Recommendations for Further Research

Geographic information is collected from various sources (refer to Figure 2-6). Mapping of environmental authorisations is a crucial area of obtaining geographic information which can contribute to the reporting on SDGs and ultimately sustainable development. Given the various types of geographic information that can be obtained from EIAs, what exactly to focus on? There are various stakeholders with relevant information, and partnerships need to be formed, given the magnitude of the project and considering that reviewing EIA reports was legislated in 1997. There is also a need for a clear direction in terms of how to carry a project of this magnitude forward. Further research could provide some guidance.

In NEMA there are more instruments (see Figure 2-1) other than EIAs. It would be interesting to see if the geographic information competencies required for other instruments would be distinctly different to the ones identified in this research for EIA report review.

Currently, the EAP qualification mentions mapping, GIS and technology. Given the significant similarities in the geographic information competencies for GIS professionals and EIA officials, further investigation is required as to whether there is a need for EIA regulators also to be registered as GISc practitioners. Or the South African Geomatics Council (SAGC) could open up another unit that will register EIA officials.

Literature review (Section 2.8.1) has emphasised the importance of strengthening the capacity of EIA regulators. Hence this thesis has focused on the geographic information competencies required by EIA officials. It has been noted that these competencies are an extension of those included in the EAP qualification standard SAQA ID 61831. This qualification is for EA practitioners not EIA officials only. However, the taxonomy in Chapter 7 focuses on geographic information competencies based on reviewing the EIA report submitted for decision making. There is a need for future research to focus on geographic information competencies for EAPs. There is need to investigate whether there will be any significant similarities or differences. The results of such research will also assist in improving the current EAP qualification.

Since geographic information evolves and the skills required in the workplaces change, surveys (GI-N2K and the South African GISc community, refer to Sections 2.10.1, 2.10.3 and 7.5) have been conducted to, amongst other important issues, improve the curricula and training of GISc professional so that they match the requirements of the industry. There is also a need to conduct further research to update the geographic information competencies developed in this study so that EA professionals are marketable.

The collection and analysis of data in mixed-methods research can follow different approaches such as the concurrent approach or the sequential approach. This academic study adopted the concurrent approach during collection and analysis. It would be interesting to see if a sequential approach were to be used, whether there would be different results. This would add value to the debates, discussions and controversies in the mixed methods research. Thus the body of literature grows.

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Personal Communications

Hill, R. 19 March 2021. *RE: Honours Programmes Accredited by Environmental Assessment Practitioners Association of South Africa*. Personal communication.

Jacobs, S. 31 March 2021. *RE: Use of Geographic Information in Compliance and Enforcement.* Personal communication.

Marais, D. 04 June 2020. *RE: Spatial Data Infrastructure related matters.* Personal communication.

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Smit, D. 16 May 2019. *RE: Use of Geographic Information in EIA Review.* Personal communication.

Annexures

Annexure 3.1 Ethics Approval

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Humanities 100.
1919 - 2019
Research Ethics Committee

3 July 2019

Dear Miss SBP Hlela

Project Title:	Towards understanding geographic information competencies: The case of decision making in environmental management in South Africa
Researcher:	Miss SBP Hlela
Supervisor:	
Department:	External department
Reference number:	28366086 (NAS112/2019)
Degree:	Doctoral

I have pleasure in informing you that the above application was **approved** by the Research Ethics Committee on 27 June 2019. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely

MMSchoeman

Prof Maxi Schoeman
Deputy Dean: Postgraduate and Research Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: PGHumanities@up.ac.za

Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Research Ethics Committee Members: Prof MME Schoeman (Deputy Dean): Prof KL Harris; Mr A Bizos; Dr L Blokland; Dr K Booyens; Dr A-M de Beer; Ms A dos Santos; Dr R Fasselt; Ms KT Govinder Andrew; Dr E Johnson; Dr W Kelleher; Mr A Mohamed; Dr C Puttergill; Dr D Reyburn; Dr M Soer; Prof E Taliard; Prof V Thebe; Ms B Tsebe; Ms D Mokalapa

Annexure 3.2 Letters of support from DG and HODs

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Private Bag X447, Pretoria, 0001• Environment House 473 Steve Biko Road, Pretoria, 0002
Tel: +27 12 399 9000, Fax: +27 12 359 3625 Email: DG@environment.gov.za

Ref: EDMS 135845
Enquiries: Ms S Hlela
Tel: 012 399 9322 **Email:** shlela@environment.gov.za

Mr S Kgopong
HOD: Department of Economic Development, Environment and Tourism
Private Bag X9484
POLOKWANE
0700

Email: MokgokongRT@ledet.gov.za

Dear Mr Kgopong

REQUEST FOR THE PARTICIPATION OF YOUR DEPARTMENT IN MS SBP HLELA'S INDEPENDENT PhD RESEARCH PROJECT TO BE CONDUCTED THROUGH THE UNIVERSITY OF PRETORIA

Ms Hlela, Director: Integrated Environmental Management: Capacity and Support Directorate has submitted her request for ethical clearance and permission to conduct her independent PhD research project to be conducted through the University of Pretoria.

The importance of study for the Department of Environmental Affairs, provinces and parastatals has been considered. The department therefore, grants permission of ethical clearance for Ms Hlela's independent PhD research project to be conducted through the University of Pretoria.

The attached document explains the rationale and the significance of her independent PhD research project. She requests that your organisation participates in her study. Participants will be provided with a consent form which will state clearly that participation is voluntary and anonymous.

The attached letter of support has been prepared for your signature. Should you concur with the contents of the letter, please put it formally in your organisation's letterhead, sign and send it back to Ms Hlela through Email: shlela@environment.gov.za.

Yours sincerely

Ms Nosipho Ngcaba
DIRECTOR-GENERAL
DATE: 07/12/2015

Batho pele- puting people first

Province of the
EASTERN CAPE
ECONOMIC DEVELOPMENT,
ENVIRONMENTAL AFFAIRS & TOURISM

Contact Person: Pendulwa Guma Tel: 043 605 7096 | Fax: | Cell: 071 882 5247 | Email: pendulwa.guma@dedea.gov.za

03 March 2016

Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Hatfield
PRETORIA
0028

Email: Karen.harris@zoology.up.ac.za

Dear Prof Harris

ACCEPTANCE OF PARTICIPATION IN MS SBP HLELA'S INDEPENDENT PhD RESEARCH PROJECT TO BE CONDUCTED THROUGH THE UNIVERSITY OF PRETORIA

The department has reviewed the request submitted by Ms Hlela for the department to participate in her independent PhD research project to be conducted through the University of Pretoria.

The importance of the study for the department has been considered, therefore the department commits itself to participate in Ms Hlela's independent PhD research project as follows:

Project: Competency maturity model for geographic information for South Africa
Researcher: SBP Hlela
Supervisors: Prof. S Coetzee and Dr A Cooper
Department: Geography, Geoinformatics and Meteorology
Reference Number: 28366086

Yours sincerely

Mr. Bongani Gxilishe
Head of Department: DEDEAT

Date: 03.03.2016

1 | Page

GAUTENG PROVINCE
AGRICULTURE AND RURAL DEVELOPMENT
REPUBLIC OF SOUTH AFRICA

Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Private Bag X20
Hatfield
PRETORIA
0028

Email: karen.harris@zoology.up.ac.za

Dear Prof Harris

ETHICAL CLEARANCE AND ACCEPTANCE OF PARTICIPATION IN MS SBP HLELA'S INDEPENDENT PhD RESEARCH PROJECT TO BE CONDUCTED THROUGH THE UNIVERSITY OF PRETORIA

The department has reviewed the request submitted by Ms Hlela for the department to participate in her independent PhD research project to be conducted through the University of Pretoria.

The importance of study for the department has been considered. Therefore, the department grants permission of the ethical clearance for Ms Hlela's independent PhD research project to be conducted through the University of Pretoria.

Project: Competency maturity model for geographic information for South Africa; Researcher: S B P Hlela; Supervisors: Prof. S Coetzee and Dr A Cooper; Department: Geography, Geoinformatics and Meteorology; Reference Number: 28366086.

The department wishes Ms Hlela all the best in her studies.

Yours sincerely

Ms T Mbassa-Sigabi
HEAD OF DEPARTMENT
DATE: 02/03/16

11 Diagonal Street, Diamond Building, Newtown, Johannesburg, 2000. Tel: 011 240 25000, Fax: 011 240 2700
Website: www.gdard.gpg.gov.za

edtea
Department :
Economic Development, Tourism and Environmental Affairs
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Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Private Bag X20
Hatfield
PRETORIA
0028

Email: karen.harris@zoology.up.ac.za

Dear Prof Harris

ETHICAL CLEARANCE AND ACCEPTANCE OF PARTICIPATION IN MS SBP HLELA'S INDEPENDENT PhD RESEARCH PROJECT TO BE CONDUCTED THROUGH THE UNIVERSITY OF PRETORIA

The Department of Economic Development, Tourism and Environmental Affairs has received a request from Ms Hlela for the Department to participate in her independent PhD research project to be conducted through the University of Pretoria.

The Department has considered the relevance and importance of the study and grants permission of ethical clearance for Ms Hlela's independent PhD research project to be conducted through the University of Pretoria.

Project: Competency maturity model for geographic information for South Africa; Researcher: S B P Hlela; Supervisors: Prof. S Coetzee and Dr A Cooper; Department: Geography, Geoinformatics and Meteorology; Reference Number: 28366086.

The Department wishes Ms Hlela all the best in her studies.

Yours sincerely

MR DESMOND GOLDING
HEAD OF DEPARTMENT

DATE: **6 July 2016**

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
ECONOMIC DEVELOPMENT, ENVIRONMENT & TOURISM

Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Private Bag X20
Hatfield
PRETORIA
0028

Email: karen.harris@zoology.up.ac.za

Dear Prof Harris

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The department wishes Ms Hlela all the best in her studies.

Yours sincerely

Mr Solomon Kgopong
HEAD OF DEPARTMENT

DATE: 28/01/2016

agriculture, rural development, land & environmental affairs
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Building No. 6, No. 7 Government Boulevard, Riverside Park, 1200, Mpumalanga Province
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Tel: +27 (013) 766 6067/8, Fax: +27 (013) 766 8295, Int Tel: +27 (13) 766 6067/8, Int Fax: +27 (13) 766 8295

Litiko Letekulima, Kutfutfukiswa Kwetindzawo Tasemakhaya, Temhlaba Netesimondzawo

Departement van Landbou, Landelike Ontwikkeling, Grond en Ongewing Sake

umNyango weZelimo UkuThuthukiswa kweeNdawo zemaKhaya, iNarha neeNdaba zeBhoduluko

Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Private Bag X20
Hatfield
PRETORIA
0028

Email: karen.harris@zoology.up.ac.za

Dear Prof Harris

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Project: Competency maturity model for geographic information for South Africa; Researcher: S B P Hlela; Supervisors: Prof. S Coetzee and Dr A Cooper; Department: Geography, Geoinformatics and Meteorology; Reference Number: 28366086.

The department wishes Ms Hlela all the best in her studies.

Yours sincerely

Ms Sindiswe Prudence Xulu
HEAD OF DEPARTMENT
DATE: 3/08/2016

the denc

Department:
Environment & Nature Conservation
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

Private Bag X6102, Kimberley, 8300, Metlife Towers, T-Floor, Tel: 053 807 7300, Fax: 053 807 7328

Enquiries: B Botes *Ref: L2.6.1* *Date: 27 January 2016*

Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Private Bag X20
Hatfield
PRETORIA
0028

Email: karen.harris@zoology.up.ac.za

Dear Prof Harris

ETHICAL CLEARANCE AND ACCEPTANCE OF PARTICIPATION IN MS SBP HLELA'S INDEPENDENT PhD RESEARCH PROJECT TO BE CONDUCTED THROUGH THE UNIVERSITY OF PRETORIA

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Project: Competency maturity model for geographic information for South Africa; Researcher: S B P Hlela; Supervisors: Prof. S Coetzee and Dr A Cooper; Department: Geography, Geoinformatics and Meteorology; Reference Number: 28366086.

The department wishes Ms Hlela all the best in her studies.

Kind Regards

Botha

MS G BOTHA
HEAD OF DEPARTMENT
DATE:

Western Cape Government
Environmental Affairs and Development Planning

HEAD OF DEPARTMENT
PIET VAN ZYL

Ref: 3/3/R

Prof K Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
University of Pretoria
Private Bag X20
Hatfield
PRETORIA
0028

Email: karen.harris@zoology.up.ac.za

Dear Prof Harris

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Project: Competency maturity model for geographic information for South Africa; Researcher: S B P Hlela; Supervisors: Prof. S Coetzee and Dr A Cooper; Department: Geography, Geoinformatics and Meteorology; Reference Number: 28366086.

The department wishes Ms Hlela all the best in her studies.

Yours sincerely

PIET VAN ZYL
HEAD OF DEPARTMENT
DATE: 11.02.2016

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Annexure 3.3 Guiding questions for the semi-structured interviews

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Interview

Participant consent form

Towards understanding value of geographic information.

Dear Participant

You are invited to participate in my independent PhD research project. The Director-General of the Department of Environmental Affairs approved my submission for ethical clearance and permission to conduct this independent PhD research project through the University of Pretoria. The aim of this research is to understand geographic information competencies for decision-making. Specifically, the focus is on competencies required for reviewing Environmental Impact Assessments (EIAs). The information collected through this interview will be used to create an understanding about the use and value of geographic information.

Your participation in this research is voluntary. The interview will be conducted either face to face or telephonically. You are requested to answer questions with honesty as the information obtained through this research will be used to create an understanding about the use and value of geographic information as well as make recommendations. Therefore, it might take an hour to go through the interview.

Furthermore you are advised that data for this research will be stored in the Department of Geography, Geoinfomatics and Meteorology according to the University Policy. The results or part of the results of this PhD research may be published in an academic literature.

Results of the study are available on request. If you are willing to participate in this study, please tick the check box below as a declaration of your consent, i.e., you participate in this project willingly and that you understand that you can withdraw from this research project at any time without negative consequences.

☐

I consent to participate and I can withdraw at any time without any negative consequences.

Thank you for your time and cooperation.

For more information, please contact me on sbuhlela1@gmail.com or my Supervisors Prof. Serena Coetzee serenacoetzee@gmail.com or Dr Antony Cooper acooper@csir.co.za

Introduction

Geographic information is the information that represents the geographic location and characteristics of natural and constructed features on earth.

As a result of numerous terms used for geographic information, I will be using the following terms interchangeably through the questionnaire to accommodate other terms that people are familiar with:

Spatial data, geographic data, GIS data, spatial information, geo-information, geospatial data, geospatial information

Examples of geographic information

Aerial photographs

Satellite photographs

Hardcopy maps

GIS map layers

Maps from Google Earth, Google Maps, OpenStreetMap

Surveys such as land surveys, topographic surveys and field surveys

Section A: information about the participant.

1. Where do you work? Please tick the appropriate box below

National Department	
Eastern Cape province	
Free State province	
Gauteng province	

KwaZulu-Natal province	
Limpopo province	
Mpumalanga province	
Northern Cape province	
North-West province	
Western Cape province	

2. How many years have you been reviewing EIAs? Please write the number of years in the space provided below.

3. What is your highest qualification?

Diploma	
Bachelor's degree	
Honours	
Master's	
PhD	

4. If your qualification is not any of the above, please specify by typing yours below.

5. To ascertain how much education and training you have in GIS, please tick all of the boxes below that apply to you.

Two weeks or less of training in GIS	
One or more semester modules in GIS	
Diploma in GIS	
Bachelor’s degree in GIS	
Honours degree in GIS	
Master’s degree in GIS	
PhD in GIS	
Honours research project using GIS	
Master’s research project using GIS	
PhD research project using GIS	
Bachelor’s degree with GIS courses	
Honours degree with GIS courses	
Master’s degree with GIS courses	
PhD with GIS courses	

6. To ascertain how much education and training you have in remote sensing, please select all the appropriate boxes below.

Two weeks or less of training in remote sensing	
One or more semester modules in remote sensing.	
Diploma in remote sensing	
Bachelor's degree in remote sensing	
Honours degree in remote sensing	
Master's degree in remote sensing	
PhD in remote sensing	
Honours research project using remote sensing	
Master's research project using remote sensing	
PhD research project using remote sensing	
Bachelor's degree with remote sensing courses	
Honours degree with remote sensing courses	
Master's degree with remote sensing courses	
PhD with remote sensing courses	

7. Any other training or qualification related to GIS or remote sensing, not mentioned above, please specify:

………
………
……

8. For your job, do you feel you need to do more courses in GIS?

☐ Yes

☐ No

9. If No, please write your reason in the space below.

10. If you could do more courses in GIS and or remote sensing, which knowledge areas or skills would you like to improve in order to function more effectively? Mention at least three important areas for you.

a) ……

b) ………..

c)……..

Section B: The questions about the use of geographic information in the review of EIAs.

Category 1: Use of geographic information

11. Do you use geographic information in reviewing EIAs? Yes or No.

12. If Yes, when did you start using geographic information in the review of EIAs?

13. If you never use it, skip to Section C.

14. What prompted you to start using geographic information?

15. In your actual review of EIAs, how are you using geographic information, or in which specific areas in the assessment process, are you using geographic information?

Category 2: Value of geographic information

16. So, ever since you started, how is it helping your review and decision-making work?

17. Any challenges or disadvantages?

Category 3: Understanding of geographic information

18. In your understanding what does it take to be able to use geographic information in EIA review?

19. In your understanding, what are the geographic information competencies that are required in order to review EIA?

Category 4: Improvement strategies

20. Knowing the importance of geographic information in the EIA, what can be done to encourage the use by officials?

21. How well do you think the legislation deals with the use of geographic information in the EIA review, especially by officials?

Section C: For those who are not using geographic information.

22. As you are currently not using geographic information in the review of EIAs, why or what is your reason or challenge that is causing you to be unable to make use of it.

23. Would you be interested in knowing more about geographic information?

24. Would you be happy if you were to learn how to use it in the EIA review?

☐ Yes

☐ No

25. Before we conclude the interview, are you aware of **any academic document** that has documented the use of GI in the review of EIA and decision-making in South Africa or in any other country?

☐ Yes

26. If yes, please let me know the title or how can I get hold of it

……
……
……..

☐ No

27. Is there anything else that you would like to cover as we conclude the interview?

I would like to thank you for the time spent in providing this valuable information. If you would like to get a copy of the final report via email, please enter your email address below.

Email: ___________________________

When I have received the responses, I will need to further develop and validate the responses. I will be grateful if you could kindly provide me with your name and email address.

Name:

Can I approach you for follow-up questions?

Yes

No

If you have any further comments you are welcome to add them below this section.

Thank you very much for your participation.

Annexure 3.4 Survey questionnaire

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Questionnaire

Participant consent form

Towards understanding value of geographic information.

Dear Participant

You are invited to participate in my independent PhD research project. The Director-General of the Department of Environmental Affairs approved my submission for ethical clearance and permission to conduct this independent PhD research project through the University of Pretoria. The aim of this research is to understand geographic information competencies for decision-making. Specifically, the focus is on geographic information competencies required for reviewing Environmental Impact Assessments (EIAs). The information collected through this questionnaire will be used to create an understanding about the use and value of geographic information.

Your participation in this research is voluntary. The questionnaire will be completed electronically and submitted through a website. If you are not able to access the website please contact me for alternative arrangements. This questionnaire will take approximately 20 minutes to complete. You are requested to answer these questions with honesty as the information obtained through this research will be used to create an understanding about the use and value of geographic information. It will also be used to make recommendations and for further developments in developing relevant geographic information competencies.

Furthermore you are advised that data for this research will be stored in the Department of Geography, Geoinfomatics and Meteorology according to the University Policy. The results or part of the results of this PhD research may be published in an academic literature.

Results of the study are available on request. If you are willing to participate in this study, please tick the check box below as a declaration of your consent, i.e., you participate in this project willingly and that you understand that you can withdraw from this research project at any time without negative consequences.

I consent to participate and I can withdraw at any time without any negative consequences. Please indicate by putting X in the box below

If you are not willing to participate, you can put X in the box below or type yes and send the form back to me by email.

For more information, please contact me on sbuhlela1@gmail.com or my Supervisors Prof. Serena Coetzee serenacoetzee@gmail.com or Dr Antony Cooper acooper@csir.co.za

Introduction

Geographic information is the information that represents the geographic location and characteristics of natural and constructed features on earth.

As a result of numerous terms used for geographic information, I will be using the following terms interchangeably through the questionnaire to accommodate other terms that people are familiar with:

Spatial data, geographic data, GIS data, spatial information, geo-information, geospatial data, geospatial information

Examples of geographic information

Aerial photographs

Satellite photographs

Hardcopy maps

GIS map layers

Maps from Google Earth, Google Maps, OpenStreetMap

Surveys such as land surveys, topographic surveys and field surveys

Section A: information about the participant.

1. Where do you work? Please put X in the appropriate box below

DEA	
Eastern Cape province	
Free State province	
Gauteng province	
KwaZulu-Natal province	
Limpopo province	
Mpumalanga province	
Northern Cape province	
North-West province	
Western Cape province	

2. How many years have you been reviewing EIAs?

3. What is your highest qualification?

Diploma	
Bachelor's degree	
Honours	
Master's degree	
PhD	

4. If your qualification is not any of the above, please specify by typing yours below.

5. To ascertain how much education and training you have in GIS and/or remote sensing, please tick all the boxes below that apply to you.

No GIS training	
Two weeks or less of training in GIS	
One or more semester modules in GIS	
Diploma in GIS	
Bachelor’s degree in GIS	
Honours degree in GIS	
Master’s degree in GIS	
PhD in GIS	
Honours research project using GIS	
Master’s research project using GIS	
PhD research project using GIS	
Bachelor’s degree with GIS courses	
Honours degree with GIS courses	
Master’s degree with GIS courses	
PhD with GIS courses	

6. To ascertain how much education and training you have in remote sensing, please tick all the boxes below that apply to you.

No remote sensing training	

Two weeks or less of training in remote sensing	
One or more semester modules in remote sensing.	
Diploma in remote sensing	
Bachelor's degree in remote sensing	
Honours degree in remote sensing	
Master's degree in remote sensing	
PhD in remote sensing	
Honours research project using remote sensing	
Master's research project using remote sensing	
PhD research project using remote sensing	
Bachelor's degree with remote sensing courses	
Honours degree with remote sensing courses	
Master's degree with remote sensing courses	
PhD with remote sensing courses	

7. Any other training or qualification related to GIS or remote sensing not mentioned above, please specify:

8. For your job, do you feel you need to do more courses in GIS?

☐ Yes

☐ No

9. If NO, please write your reason/s in the space below.

10. If you could do more courses in GIS and or remote sensing, which knowledge areas or skills would you like to improve in order to function more effectively? Mention at least three important areas for you.

a)

b)

c)

11. Please read the statements and the question below and select the most appropriate answer for you.

	Never	Rarely	Sometimes	Often	Daily
Please indicate your frequency of use of the web and browsing at work					
Please indicate your frequency of use of the web and browsing at home					

Please indicate your frequency of use of geographic information in the review of EIAs					
Do you have access to the geographic information you need for the review of EIAs?					

12. Below are some of the ways in which geographic information can be used in reviewing EIAs. To what extent do you agree or disagree with the statements below?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Geographic information can be used to visualise the location					
Geographic information can be used to verify site visit information					
Geographic information can be used to verify surrounding uses					
Geographic information can be used to make correct decisions about the					

location of a proposed development					
Geographic information can be used to measure trends of development on the location					
Geographic information can be used to make informed decisions					

13. Who benefits from the use of geographic information? Please put, Yes, if you agree or No if you do not agree.

	Yes	No
Applicant		
Consultant EAP		
Reviewer EAP		
Decision maker / Competent Authority		

14. Please indicate your level of awareness of the terms below.

	Not at all aware	Slightly aware	Moderately aware	Extremely aware

South African Spatial Data Infrastructure (SASDI)				
Spatial Data Infrastructure (SDI)				
Spatial Data Infrastructure (SDI) Act No. 54 of 2003				

15. In your understanding what does it take to be able to use geographic information in EIA review? To what extent do you feel each of the following options is sufficient to perform an EIA review?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Formal training and experience					
Some form of training					
Some form of training and experience					
Experience only					

16. In your understanding, what are the geographic information competencies that are required in order to review EIAs? Rate the following geographic information competencies. You are welcome to rate more than one under the same category.

	Very important	Important	Fairly important	Slightly important	Not important
Understanding and interpretation					

of geographic information					
Processing geographic information					
Some form of basic training in GIS in order to make use of Listing Notice 3 maps in terms of EIA regulations					
Map reading,					
Critical thinking					
Analytical thinking					
You need to be familiar with the GIS tool					

17. What can be done to encourage its use by EIA reviewers? Rate the following methods.

	Very important	Important	Fairly important	Slightly important	Not important
Hold information sharing conferences and seminars					
Each office should have a GIS station					

Training of EIA reviewers					
Exposure of officials to benefits of geographic information					
Case studies					
Training manuals					

18. How well do you think the legislation deals with the use of geographic information by officials reviewing EIAs? Please provide your answer by ticking in the box below.

Very well	Adequately	Poorly	It does not mention use of geographic information all	Don’t know

19. Would you be interested in knowing more about geographic information?

Yes	No

20. Would you be happy if you were to learn how to use geographic information in the EIA review?

Yes	No

21. Are you aware of **any academic document** that has documented the use of geographic information in the review of EIA and decision-making in South Africa or in any other country?

Yes	
No	

22. If yes to the above question, please let me know the title and how can I get hold of it.

I would like to thank you for the time spent in providing this invaluable information. If you would like to get a copy of the final report via email, please enter your email address below.

Email: ___________________________

When I have received the responses, I will need to further develop and validate the responses. Can I approach you for follow-up questions at the above email? If yes, I will be grateful if you could kindly provide me with your name.

Name: Email:

Yes	
No	

If you have any further comments, you are welcome to add them in the space provided below.

Thank you very much for your participation.

Annexure 3.5 Reminders about the survey

Sbu Hlela <sbuhlela1@gmail.com> Dec 17, 2019, 5:06 PM

to [redacted]

Dear Colleagues

I sent you my survey requesting you to participate in my PhD survey project. If you receive an e-mail from u28366086@tuks.co.za, please know it is my e-mail account from the University of Pretoria.

I will appreciate if you could assist me in my data collection.

Thank you

Sibusisiwe Hlela
Director:Integrated Environmental Management : Capacity and Support
DEA
Tel: 012 399 9322
Cell: 083 388 8024

Request to participate in my survey Inbox x

Sbu Hlela <sbuhlela1@gmail.com> Mon, Feb 17, 12:50 PM

to [redacted]

Hi [redacted]

Following our conversation just now, please find attached the survey questionnaire. Please pass it on to your colleagues.

I will sincerely appreciate if they can respond by the end of this week.

Thank you very much

Sbu Hlela

Annexure 4.1 Statistical analysis

SPSS Descriptive Crosstabulations Years vs Q8, 12, 13, 16, 17

Q8 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 – 11	12+	Total
Q8	No	Count	7	5	4	16
		% within How many years have you been reviewing EIAs? (Binned)	24.1%	13.2%	15.4%	17.2%
	Yes	Count	22	33	22	77
		% within How many years have you been reviewing EIAs? (Binned)	75.9%	86.8%	84.6%	82.8%
Total		Count	29	38	26	93

% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.476[a]	2	.478	.507

Likelihood Ratio	1.423	2	.491	.538
Fisher's Exact Test	1.455			.507
N of Valid Cases	93			

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.47.

Q12_1 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 – 11	12+	Total
Q12_1	Strongly disagree	Count	2	0	1	3

		% within How many years have you been reviewing EIAs? (Binned)	7.1%	0.0%	3.8%	3.3%
	Disagree	Count	0	0	1	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	3.8%	1.1%
	Agree	Count	2	7	4	13
		% within How many years have you been reviewing EIAs? (Binned)	7.1%	18.4%	15.4%	14.1%
	Strongly agree	Count	24	31	20	75
		% within How many years have you been reviewing EIAs? (Binned)	85.7%	81.6%	76.9%	81.5%
Total		Count	28	38	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.718[a]	6	.348	.323		
Likelihood Ratio	7.786	6	.254	.309		
Fisher's Exact Test	6.333			.295		
Linear-by-Linear Association	.071[b]	1	.790	.810	.428	.062
N of Valid Cases	92					

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -.266.

Q12_2 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q12_2	Strongly disagree	Count	1	0	0	1
		% within How many years have you been reviewing EIAs? (Binned)	3.4%	0.0%	0.0%	1.1%
	Disagree	Count	0	0	2	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	7.7%	2.2%
	Neither agree nor disagree	Count	1	2	0	3
		% within How many years have you been reviewing EIAs? (Binned)	3.4%	5.3%	0.0%	3.2%
	Agree	Count	4	9	3	16

		% within How many years have you been reviewing EIAs? (Binned)	13.8%	23.7%	11.5%	17.2%
	Strongly agree	Count	23	27	21	71
		% within How many years have you been reviewing EIAs? (Binned)	79.3%	71.1%	80.8%	76.3%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.541[a]	8	.229	.191		
Likelihood Ratio	11.350	8	.183	.235		

Fisher's Exact Test	8.197			.300		
Linear-by-Linear Association	.000[b]	1	.995	1.000	.532	.071
N of Valid Cases	93					

a. 11 cells (73.3%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -.006.

Q12_3 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q12_3	Strongly disagree	Count	2	0	1	3
		% within How many years have you been reviewing EIAs? (Binned)	6.9%	0.0%	3.8%	3.2%
	Disagree	Count	0	0	1	1

		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	3.8%	1.1%
	Agree	Count	3	13	5	21
		% within How many years have you been reviewing EIAs? (Binned)	10.3%	34.2%	19.2%	22.6%
	Strongly agree	Count	24	25	19	68
		% within How many years have you been reviewing EIAs? (Binned)	82.8%	65.8%	73.1%	73.1%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.021[a]	6	.124	.086		
Likelihood Ratio	11.094	6	.085	.075		
Fisher's Exact Test	9.428			.062		
Linear-by-Linear Association	.122[b]	1	.727	.753	.396	.059
N of Valid Cases	93					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -.350.

Q12_4 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q12_4	Strongly disagree	Count	2	0	0	2
		% within How many years have you been reviewing EIAs? (Binned)	7.1%	0.0%	0.0%	2.2%
	Disagree	Count	0	0	2	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	7.7%	2.2%
	Neither agree nor disagree	Count	1	4	2	7
		% within How many years have you been reviewing EIAs? (Binned)	3.6%	10.5%	7.7%	7.6%
	Agree	Count	7	18	8	33

		% within How many years have you been reviewing EIAs? (Binned)	25.0%	47.4%	30.8%	35.9%
	Strongly agree	Count	18	16	14	48
		% within How many years have you been reviewing EIAs? (Binned)	64.3%	42.1%	53.8%	52.2%
Total		Count	28	38	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	14.725[a]	8	.065	.044		
Likelihood Ratio	14.981	8	.060	.079		

Fisher's Exact Test	11.225			.095		
Linear-by-Linear Association	.129[b]	1	.719	.760	.390	.057
N of Valid Cases	92					

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is.57.

b. The standardized statistic is -.360.

Q12_5 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q12_5	Strongly disagree	Count	2	0	1	3
		% within How many years have you been reviewing EIAs? (Binned)	6.9%	0.0%	3.8%	3.3%

	Disagree	Count	0	0	1	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	3.8%	1.1%
	Neither agree nor disagree	Count	2	6	1	9
		% within How many years have you been reviewing EIAs? (Binned)	6.9%	16.2%	3.8%	9.8%
	Agree	Count	10	15	5	30
		% within How many years have you been reviewing EIAs? (Binned)	34.5%	40.5%	19.2%	32.6%
	Strongly agree	Count	15	16	18	49
		% within How many years have you been reviewing EIAs? (Binned)	51.7%	43.2%	69.2%	53.3%
Total		Count	29	37	26	92

	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	11.824[a]	8	.159	.128		
Likelihood Ratio	12.917	8	.115	.141		
Fisher's Exact Test	10.962			.122		
Linear-by-Linear Association	.734[b]	1	.392	.433	.219	.040
N of Valid Cases	92					

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is.857.

Q12_6 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q12_6	Strongly disagree	Count	2	0	0	2
		% within How many years have you been reviewing EIAs? (Binned)	6.9%	0.0%	0.0%	2.2%
	Disagree	Count	0	0	1	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	3.8%	1.1%
	Neither agree nor disagree	Count	1	0	2	3
		% within How many years have you been reviewing EIAs? (Binned)	3.4%	0.0%	7.7%	3.2%
	Agree	Count	5	19	9	33

		% within How many years have you been reviewing EIAs? (Binned)	17.2%	50.0%	34.6%	35.5%
	Strongly agree	Count	21	19	14	54
		% within How many years have you been reviewing EIAs? (Binned)	72.4%	50.0%	53.8%	58.1%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	16.344[a]	8	.038	.014		
Likelihood Ratio	17.669	8	.024	.014		

Fisher's Exact Test	14.343			.014		
Linear-by-Linear Association	.194[b]	1	.660	.680	.363	.060
N of Valid Cases	93					

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -.440.

Q13_1 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q13_1	Yes	Count	22	30	24	76
		% within How many years have you been reviewing EIAs? (Binned)	75.9%	78.9%	92.3%	81.7%
	No	Count	7	8	2	17
		% within How many years have you been reviewing EIAs? (Binned)	24.1%	21.1%	7.7%	18.3%

Total	Count	29	38	26	93
	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.813[a]	2	.245	.258		
Likelihood Ratio	3.193	2	.203	.212		
Fisher's Exact Test	2.880			.226		
Linear-by-Linear Association	2.390[b]	1	.122	.164	.084	.043
N of Valid Cases	93					

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.75.

b. The standardized statistic is -1.546.

Q13_2 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q13_2	Yes	Count	28	38	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%
Total		Count	28	38	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	92

a. No statistics are computed because Q13_2 is a constant.

Q13_3 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q13_3	Yes	Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	93

a. No statistics are computed because Q13_3 is a constant.

Q13_4 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q13_4	Yes	Count	28	38	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%
Total		Count	28	38	26	92

	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	92

a. No statistics are computed because Q13_4 is a constant.

Q16_1 * How many years have you been reviewing EIAs? (Binned)

Crosstab

	How many years have you been reviewing EIAs? (Binned)			Total
	<= 5	6 - 11	12+	

Q16_1	Slightly important	Count	0	2	0	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	5.3%	0.0%	2.2%
	Fairly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	0.0%	1.1%
	Important	Count	4	6	4	14
		% within How many years have you been reviewing EIAs? (Binned)	13.8%	15.8%	15.4%	15.1%
	Very important	Count	25	29	22	76
		% within How many years have you been reviewing EIAs? (Binned)	86.2%	76.3%	84.6%	81.7%
Total		Count	29	38	26	93

	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.622[a]	6	.593	.662		
Likelihood Ratio	5.652	6	.463	.632		
Fisher's Exact Test	3.688			.861		
Linear-by-Linear Association	.027[b]	1	.869	.910	.480	.089
N of Valid Cases	93					

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -.166.

Q16_2 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q16_2	Not important	Count	0	2	0	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	5.4%	0.0%	2.2%
	Slightly important	Count	1	0	2	3
		% within How many years have you been reviewing EIAs? (Binned)	3.6%	0.0%	7.7%	3.3%
	Fairly important	Count	5	4	1	10
		% within How many years have you been reviewing EIAs? (Binned)	17.9%	10.8%	3.8%	11.0%
	Important	Count	8	12	7	27

		% within How many years have you been reviewing EIAs? (Binned)	28.6%	32.4%	26.9%	29.7%
	Very important	Count	14	19	16	49
		% within How many years have you been reviewing EIAs? (Binned)	50.0%	51.4%	61.5%	53.8%
Total		Count	28	37	26	91
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.657[a]	8	.372	.385		
Likelihood Ratio	10.341	8	.242	.349		

Fisher's Exact Test	7.361			.452		
Linear-by-Linear Association	.435[b]	1	.510	.523	.281	.046
N of Valid Cases	91					

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is.57.

b. The standardized statistic is.659.

Q16_3 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q16_3	Slightly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	0.0%	1.1%

	Fairly important	Count	4	9	0	13
		% within How many years have you been reviewing EIAs? (Binned)	13.8%	23.7%	0.0%	14.0%
	Important	Count	7	7	12	26
		% within How many years have you been reviewing EIAs? (Binned)	24.1%	18.4%	46.2%	28.0%
	Very important	Count	18	21	14	53
		% within How many years have you been reviewing EIAs? (Binned)	62.1%	55.3%	53.8%	57.0%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	12.306[a]	6	.055	.035		
Likelihood Ratio	15.503	6	.017	.014		
Fisher's Exact Test	12.596			.026		
Linear-by-Linear Association	.046[b]	1	.830	.862	.450	.068
N of Valid Cases	93					

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is.215.

Q16_4 * How many years have you been reviewing EIAs? (Binned)

Crosstab

	How many years have you been reviewing EIAs? (Binned)			
	<= 5	6 - 11	12+	Total

Q16_4	Fairly important	Count	1	1	1	3
		% within How many years have you been reviewing EIAs? (Binned)	3.4%	2.6%	3.8%	3.2%
	Important	Count	6	11	9	26
		% within How many years have you been reviewing EIAs? (Binned)	20.7%	28.9%	34.6%	28.0%
	Very important	Count	22	26	16	64
		% within How many years have you been reviewing EIAs? (Binned)	75.9%	68.4%	61.5%	68.8%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	1.461[a]	4	.834	.886		
Likelihood Ratio	1.488	4	.829	.892		
Fisher's Exact Test	1.947			.818		
Linear-by-Linear Association	1.009[b]	1	.315	.324	.190	.060
N of Valid Cases	93					

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is.84.

b. The standardized statistic is -1.005.

Q16_5 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q16_5	Fairly important	Count	0	4	1	5
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	10.5%	3.8%	5.4%
	Important	Count	12	9	15	36
		% within How many years have you been reviewing EIAs? (Binned)	41.4%	23.7%	57.7%	38.7%
	Very important	Count	17	25	10	52
		% within How many years have you been reviewing EIAs? (Binned)	58.6%	65.8%	38.5%	55.9%
Total		Count	29	38	26	93

% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.354[a]	4	.035	.029		
Likelihood Ratio	11.690	4	.020	.026		
Fisher's Exact Test	9.780			.028		
Linear-by-Linear Association	2.119[b]	1	.145	.178	.090	.031
N of Valid Cases	93					

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 1.40.

b. The standardized statistic is -1.456.

Q16_6 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q16_6	Slightly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.7%	0.0%	1.1%
	Fairly important	Count	0	0	1	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	0.0%	3.8%	1.1%
	Important	Count	10	13	14	37
		% within How many years have you been reviewing EIAs? (Binned)	35.7%	35.1%	53.8%	40.7%
	Very important	Count	18	23	11	52

	% within How many years have you been reviewing EIAs? (Binned)	64.3%	62.2%	42.3%	57.1%
Total	Count	28	37	26	91
	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.932[a]	6	.327	.261		
Likelihood Ratio	7.281	6	.296	.264		
Fisher's Exact Test	6.549			.263		
Linear-by-Linear Association	2.611[b]	1	.106	.129	.067	.026
N of Valid Cases	91					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.29.

b. The standardized statistic is -1.616.

Q16_7 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q16_7	Slightly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	0.0%	1.1%
	Fairly important	Count	0	6	3	9
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	15.8%	11.5%	9.8%
	Important	Count	9	11	10	30
		% within How many years have you been reviewing EIAs? (Binned)	32.1%	28.9%	38.5%	32.6%
	Very important	Count	19	20	13	52

	% within How many years have you been reviewing EIAs? (Binned)	67.9%	52.6%	50.0%	56.5%
Total	Count	28	38	26	92
	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.009[a]	6	.320	.302		
Likelihood Ratio	9.832	6	.132	.140		
Fisher's Exact Test	7.433			.230		
Linear-by-Linear Association	2.373[b]	1	.123	.130	.075	.024

N of Valid Cases	92					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -1.540.

Q17_1 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q17_1	Not important	Count	0	1	1	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.7%	3.8%	2.2%
	Slightly important	Count	1	3	1	5

		% within How many years have you been reviewing EIAs? (Binned)	3.6%	8.1%	3.8%	5.5%
	Fairly important	Count	5	4	12	21
		% within How many years have you been reviewing EIAs? (Binned)	17.9%	10.8%	46.2%	23.1%
	Important	Count	5	13	7	25
		% within How many years have you been reviewing EIAs? (Binned)	17.9%	35.1%	26.9%	27.5%
	Very important	Count	17	16	5	38
		% within How many years have you been reviewing EIAs? (Binned)	60.7%	43.2%	19.2%	41.8%
Total		Count	28	37	26	91
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	17.824[a]	8	.023	.015		
Likelihood Ratio	18.193	8	.020	.025		
Fisher's Exact Test	17.082			.011		
Linear-by-Linear Association	8.307[b]	1	.004	.004	.002	.001
N of Valid Cases	91					

a. 6 cells (40.0%) have expected count less than 5. The minimum expected count is.57.

b. The standardized statistic is -2.882.

Q17_2 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q17_2	Not important	Count	0	2	0	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	5.4%	0.0%	2.2%
	Slightly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.7%	0.0%	1.1%
	Fairly important	Count	2	2	1	5
		% within How many years have you been reviewing EIAs? (Binned)	6.9%	5.4%	3.8%	5.4%
	Important	Count	5	8	7	20

		% within How many years have you been reviewing EIAs? (Binned)	17.2%	21.6%	26.9%	21.7%
	Very important	Count	22	24	18	64
		% within How many years have you been reviewing EIAs? (Binned)	75.9%	64.9%	69.2%	69.6%
Total		Count	29	37	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	5.569[a]	8	.695	.781		
Likelihood Ratio	6.575	8	.583	.767		

Fisher's Exact Test	4.741			.890		
Linear-by-Linear Association	.047[b]	1	.828	.873	.446	.062
N of Valid Cases	92					

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -.217.

Q17_3 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q17_3	Fairly important	Count	0	2	0	2
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	5.4%	0.0%	2.2%
	Important	Count	3	9	4	16

		% within How many years have you been reviewing EIAs? (Binned)	10.3%	24.3%	15.4%	17.4%
	Very important	Count	26	26	22	74
		% within How many years have you been reviewing EIAs? (Binned)	89.7%	70.3%	84.6%	80.4%
Total		Count	29	37	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	5.722[a]	4	.221	.219		
Likelihood Ratio	6.433	4	.169	.198		

Fisher's Exact Test	4.525			.272		
Linear-by-Linear Association	.230[b]	1	.631	.668	.370	.102
N of Valid Cases	92					

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is.57.

b. The standardized statistic is -.480.

Q17_4 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q17_4	Slightly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	0.0%	1.1%
	Fairly important	Count	0	1	1	2

		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	3.8%	2.2%
	Important	Count	4	10	10	24
		% within How many years have you been reviewing EIAs? (Binned)	14.3%	26.3%	38.5%	26.1%
	Very important	Count	24	26	15	65
		% within How many years have you been reviewing EIAs? (Binned)	85.7%	68.4%	57.7%	70.7%
Total		Count	28	38	26	92
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.967[a]	6	.324	.321		
Likelihood Ratio	7.941	6	.242	.270		
Fisher's Exact Test	7.093			.192		
Linear-by-Linear Association	4.153[b]	1	.042	.045	.027	.012
N of Valid Cases	92					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.28.

b. The standardized statistic is -2.038.

Q17_5 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q17_5	Not important	Count	3	0	0	3
		% within How many years have you been reviewing EIAs? (Binned)	10.3%	0.0%	0.0%	3.2%
	Slightly important	Count	0	4	2	6
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	10.5%	7.7%	6.5%
	Fairly important	Count	4	6	6	16
		% within How many years have you been reviewing EIAs? (Binned)	13.8%	15.8%	23.1%	17.2%
	Important	Count	13	14	12	39

		% within How many years have you been reviewing EIAs? (Binned)	44.8%	36.8%	46.2%	41.9%
	Very important	Count	9	14	6	29
		% within How many years have you been reviewing EIAs? (Binned)	31.0%	36.8%	23.1%	31.2%
Total		Count	29	38	26	93
		% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	11.635[a]	8	.168	.163		
Likelihood Ratio	13.718	8	.089	.135		

Fisher's Exact Test	9.517			.254		
Linear-by-Linear Association	.001[b]	1	.973	1.000	.512	.052
N of Valid Cases	93					

a. 8 cells (53.3%) have expected count less than 5. The minimum expected count is.84.

b. The standardized statistic is -.034.

Q17_6 * How many years have you been reviewing EIAs? (Binned)

Crosstab

			How many years have you been reviewing EIAs? (Binned)			
			<= 5	6 - 11	12+	Total
Q17_6	Not important	Count	0	1	2	3
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	8.0%	3.3%

	Slightly important	Count	0	1	0	1
		% within How many years have you been reviewing EIAs? (Binned)	0.0%	2.6%	0.0%	1.1%
	Fairly important	Count	7	4	4	15
		% within How many years have you been reviewing EIAs? (Binned)	24.1%	10.5%	16.0%	16.3%
	Important	Count	11	15	8	34
		% within How many years have you been reviewing EIAs? (Binned)	37.9%	39.5%	32.0%	37.0%
	Very important	Count	11	17	11	39
		% within How many years have you been reviewing EIAs? (Binned)	37.9%	44.7%	44.0%	42.4%
Total		Count	29	38	25	92

	% within How many years have you been reviewing EIAs? (Binned)	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.445[a]	8	.597	.648		
Likelihood Ratio	7.221	8	.513	.652		
Fisher's Exact Test	6.000			.677		
Linear-by-Linear Association	.121[b]	1	.728	.778	.392	.053
N of Valid Cases	92					

a. 8 cells (53.3%) have expected count less than 5. The minimum expected count is.27.

b. The standardized statistic is -.347.

SPSS Descriptive Crosstabulations Q5, Q6 vs Q8, 12, 13 16 and 17

Q8 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q8	No	Count	5	5	7	0	17
		% within NQ5	23.8%	14.3%	20.6%	0.0%	18.1%
	Yes	Count	16	30	27	4	77
		% within NQ5	76.2%	85.7%	79.4%	100.0%	81.9%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.832[a]	3	.608	.591
Likelihood Ratio	2.529	3	.470	.536
Fisher's Exact Test	1.409			.702
N of Valid Cases	94			

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is.72.

Q8 * NQ6

Crosstab

NQ6				
Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total

Q8	No	Count	3	6	4	4	17
		% within NQ6	27.3%	19.4%	13.8%	18.2%	18.3%
	Yes	Count	8	25	25	18	76
		% within NQ6	72.7%	80.6%	86.2%	81.8%	81.7%
Total		Count	11	31	29	22	93
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.010[a]	3	.799	.812
Likelihood Ratio	.978	3	.806	.839
Fisher's Exact Test	1.239			.746
N of Valid Cases	93			

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.01.

b.

Q12_1 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_1	Strongly disagree	Count	2	0	1	0	3
		% within NQ5	9.5%	0.0%	3.0%	0.0%	3.2%
	Disagree	Count	0	1	0	0	1
		% within NQ5	0.0%	2.9%	0.0%	0.0%	1.1%
	Agree	Count	3	4	6	0	13
		% within NQ5	14.3%	11.4%	18.2%	0.0%	14.0%
	Strongly agree	Count	16	30	26	4	76
		% within NQ5	76.2%	85.7%	78.8%	100.0%	81.7%
Total		Count	21	35	33	4	93

% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.987[a]	9	.638	.569		
Likelihood Ratio	8.169	9	.517	.534		
Fisher's Exact Test	7.849			.647		
Linear-by-Linear Association	1.121[b]	1	.290	.299	.166	.035
N of Valid Cases	93					

a. 13 cells (81.3%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is 1.059.

Q12_1 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_1	Strongly disagree	Count	1	1	0	1	3
		% within NQ6	9.1%	3.2%	0.0%	4.8%	3.3%
	Disagree	Count	0	1	0	0	1
		% within NQ6	0.0%	3.2%	0.0%	0.0%	1.1%
	Agree	Count	2	2	7	2	13
		% within NQ6	18.2%	6.5%	24.1%	9.5%	14.1%
	Strongly agree	Count	8	27	22	18	75
		% within NQ6	72.7%	87.1%	75.9%	85.7%	81.5%
Total		Count	11	31	29	21	92

% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.379[a]	9	.496	.499		
Likelihood Ratio	9.138	9	.425	.498		
Fisher's Exact Test	9.317			.315		
Linear-by-Linear Association	.483[b]	1	.487	.518	.268	.041
N of Valid Cases	92					

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.695.

Q12_2 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_2	Strongly disagree	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%
	Disagree	Count	1	1	0	0	2
		% within NQ5	4.8%	2.9%	0.0%	0.0%	2.1%
	Neither agree nor disagree	Count	1	1	1	0	3
		% within NQ5	4.8%	2.9%	2.9%	0.0%	3.2%
	Agree	Count	3	7	5	2	17
		% within NQ5	14.3%	20.0%	14.7%	50.0%	18.1%
	Strongly agree	Count	15	26	28	2	71

	% within NQ5	71.4%	74.3%	82.4%	50.0%	75.5%
Total	Count	21	35	34	4	94
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.681[a]	12	.730	.664		
Likelihood Ratio	8.258	12	.765	.852		
Fisher's Exact Test	11.226			.584		
Linear-by-Linear Association	1.912[b]	1	.167	.189	.098	.026
N of Valid Cases	94					

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is 1.383.

Q12_2 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_2	Strongly disagree	Count	1	0	0	0	1
		% within NQ6	9.1%	0.0%	0.0%	0.0%	1.1%
	Disagree	Count	0	2	0	0	2
		% within NQ6	0.0%	6.5%	0.0%	0.0%	2.2%
	Neither agree nor disagree	Count	0	0	2	1	3
		% within NQ6	0.0%	0.0%	6.9%	4.5%	3.2%
	Agree	Count	2	6	6	3	17
		% within NQ6	18.2%	19.4%	20.7%	13.6%	18.3%
	Strongly agree	Count	8	23	21	18	70

	% within NQ6	72.7%	74.2%	72.4%	81.8%	75.3%
Total	Count	11	31	29	22	93
	% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	14.682[a]	12	.259	.235		
Likelihood Ratio	12.950	12	.373	.437		
Fisher's Exact Test	10.249			.573		
Linear-by-Linear Association	1.325[b]	1	.250	.286	.143	.030
N of Valid Cases	93					

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is 1.151.

Q12_3 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_3	Strongly disagree	Count	2	0	1	0	3
		% within NQ5	9.5%	0.0%	2.9%	0.0%	3.2%
	Disagree	Count	0	1	0	0	1
		% within NQ5	0.0%	2.9%	0.0%	0.0%	1.1%
	Agree	Count	5	6	8	2	21
		% within NQ5	23.8%	17.1%	23.5%	50.0%	22.3%
	Strongly agree	Count	14	28	25	2	69
		% within NQ5	66.7%	80.0%	73.5%	50.0%	73.4%
Total		Count	21	35	34	4	94

% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.046[a]	9	.529	.462		
Likelihood Ratio	8.369	9	.497	.518		
Fisher's Exact Test	9.457			.412		
Linear-by-Linear Association	.555[b]	1	.456	.468	.254	.045
N of Valid Cases	94					

a. 11 cells (68.8%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.745.

Q12_3 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_3	Strongly disagree	Count	1	1	0	1	3
		% within NQ6	9.1%	3.2%	0.0%	4.5%	3.2%
	Disagree	Count	0	1	0	0	1
		% within NQ6	0.0%	3.2%	0.0%	0.0%	1.1%
	Agree	Count	3	5	9	4	21
		% within NQ6	27.3%	16.1%	31.0%	18.2%	22.6%
	Strongly agree	Count	7	24	20	17	68
		% within NQ6	63.6%	77.4%	69.0%	77.3%	73.1%
Total		Count	11	31	29	22	93

% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.346[a]	9	.705	.757		
Likelihood Ratio	7.053	9	.632	.757		
Fisher's Exact Test	7.443			.608		
Linear-by-Linear Association	.597[b]	1	.440	.487	.243	.038
N of Valid Cases	93					

a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.772.

Q12_4 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_4	Strongly disagree	Count	1	0	1	0	2
		% within NQ5	4.8%	0.0%	2.9%	0.0%	2.2%
	Disagree	Count	1	1	0	0	2
		% within NQ5	4.8%	2.9%	0.0%	0.0%	2.2%
	Neither agree nor disagree	Count	1	2	3	1	7
		% within NQ5	4.8%	5.9%	8.8%	25.0%	7.5%
	Agree	Count	7	9	16	1	33
		% within NQ5	33.3%	26.5%	47.1%	25.0%	35.5%
	Strongly agree	Count	11	22	14	2	49
		% within NQ5	52.4%	64.7%	41.2%	50.0%	52.7%

Total	Count	21	34	34	4	93
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	9.204[a]	12	.685	.645		
Likelihood Ratio	9.868	12	.628	.710		
Fisher's Exact Test	11.585			.463		
Linear-by-Linear Association	.097[b]	1	.756	.782	.406	.053
N of Valid Cases	93					

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is.09.

b. The standardized statistic is -.311.

Q12_4 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_4	Strongly disagree	Count	1	0	0	1	2
		% within NQ6	9.1%	0.0%	0.0%	4.8%	2.2%
	Disagree	Count	0	2	0	0	2
		% within NQ6	0.0%	6.5%	0.0%	0.0%	2.2%
	Neither agree nor disagree	Count	1	3	1	2	7
		% within NQ6	9.1%	9.7%	3.4%	9.5%	7.6%
	Agree	Count	3	9	15	6	33
		% within NQ6	27.3%	29.0%	51.7%	28.6%	35.9%

Strongly agree	Count	6	17	13	12	48
	% within NQ6	54.5%	54.8%	44.8%	57.1%	52.2%
Total	Count	11	31	29	21	92
	% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	12.703[a]	12	.391	.387		
Likelihood Ratio	13.160	12	.357	.470		
Fisher's Exact Test	11.160			.418		
Linear-by-Linear Association	.217[b]	1	.641	.670	.344	.044
N of Valid Cases	92					

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is.24.

b. The standardized statistic is.466.

Q12_5 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_5	Strongly disagree	Count	2	0	1	0	3
		% within NQ5	9.5%	0.0%	2.9%	0.0%	3.2%
	Disagree	Count	0	1	0	0	1
		% within NQ5	0.0%	2.9%	0.0%	0.0%	1.1%
	Neither agree nor disagree	Count	0	6	2	1	9
		% within NQ5	0.0%	17.6%	5.9%	25.0%	9.7%

	Agree	Count	7	9	14	1	31
		% within NQ5	33.3%	26.5%	41.2%	25.0%	33.3%
	Strongly agree	Count	12	18	17	2	49
		% within NQ5	57.1%	52.9%	50.0%	50.0%	52.7%
Total		Count	21	34	34	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	12.615[a]	12	.398	.358		
Likelihood Ratio	14.597	12	.264	.258		
Fisher's Exact Test	13.888			.269		

Linear-by-Linear Association	.037[b]	1	.848	.896	.450	.051
N of Valid Cases	93					

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.191.

Q12_5 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_5	Strongly disagree	Count	1	1	0	1	3
		% within NQ6	9.1%	3.3%	0.0%	4.5%	3.3%
	Disagree	Count	0	1	0	0	1
		% within NQ6	0.0%	3.3%	0.0%	0.0%	1.1%

	Neither agree nor disagree	Count	0	3	4	2	9
		% within NQ6	0.0%	10.0%	13.8%	9.1%	9.8%
	Agree	Count	3	11	10	7	31
		% within NQ6	27.3%	36.7%	34.5%	31.8%	33.7%
	Strongly agree	Count	7	14	15	12	48
		% within NQ6	63.6%	46.7%	51.7%	54.5%	52.2%
Total		Count	11	30	29	22	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.554[a]	12	.886	.938		

Likelihood Ratio	8.300	12	.761	.880		
Fisher's Exact Test	7.279			.925		
Linear-by-Linear Association	.060[b]	1	.806	.820	.425	.044
N of Valid Cases	92					

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.246.

Q12_6 * NQ5

Crosstab

	NQ5	Total

			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	
Q12_6	Strongly disagree	Count	1	0	1	0	2
		% within NQ5	4.8%	0.0%	2.9%	0.0%	2.1%
	Disagree	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%
	Neither agree nor disagree	Count	0	2	1	0	3
		% within NQ5	0.0%	5.7%	2.9%	0.0%	3.2%
	Agree	Count	9	11	13	1	34
		% within NQ5	42.9%	31.4%	38.2%	25.0%	36.2%
	Strongly agree	Count	10	22	19	3	54
		% within NQ5	47.6%	62.9%	55.9%	75.0%	57.4%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.015[a]	12	.784	.734		
Likelihood Ratio	8.848	12	.716	.778		
Fisher's Exact Test	10.010			.769		
Linear-by-Linear Association	.966[b]	1	.326	.361	.185	.038
N of Valid Cases	94					

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.983.

Q12_6 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q12_6	Strongly disagree	Count	1	0	0	1	2
		% within NQ6	9.1%	0.0%	0.0%	4.5%	2.2%
	Disagree	Count	0	1	0	0	1
		% within NQ6	0.0%	3.2%	0.0%	0.0%	1.1%
	Neither agree nor disagree	Count	0	3	0	0	3
		% within NQ6	0.0%	9.7%	0.0%	0.0%	3.2%
	Agree	Count	4	10	15	5	34
		% within NQ6	36.4%	32.3%	51.7%	22.7%	36.6%
	Strongly agree	Count	6	17	14	16	53
		% within NQ6	54.5%	54.8%	48.3%	72.7%	57.0%

Total	Count	11	31	29	22	93
	% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	16.853[a]	12	.155	.129		
Likelihood Ratio	17.602	12	.128	.091		
Fisher's Exact Test	14.452			.127		
Linear-by-Linear Association	1.457[b]	1	.227	.259	.130	.026
N of Valid Cases	93					

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is 1.207.

Q13_1 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q13_1	Yes	Count	18	29	28	2	77
		% within NQ5	85.7%	82.9%	82.4%	50.0%	81.9%
	No	Count	3	6	6	2	17
		% within NQ5	14.3%	17.1%	17.6%	50.0%	18.1%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.980[a]	3	.395	.424		
Likelihood Ratio	2.336	3	.506	.615		
Fisher's Exact Test	2.835			.408		
Linear-by-Linear Association	1.033[b]	1	.310	.344	.196	.076
N of Valid Cases	94					

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is.72.

b. The standardized statistic is 1.016.

Q13_1 * NQ6

Crosstab

	NQ6	Total

			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	
Q13_1	Yes	Count	10	25	22	19	76
		% within NQ6	90.9%	80.6%	75.9%	86.4%	81.7%
	No	Count	1	6	7	3	17
		% within NQ6	9.1%	19.4%	24.1%	13.6%	18.3%
Total		Count	11	31	29	22	93
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	1.630[a]	3	.653	.680		

Likelihood Ratio	1.718	3	.633	.661		
Fisher's Exact Test	1.401			.710		
Linear-by-Linear Association	.034[b]	1	.854	.891	.483	.108
N of Valid Cases	93					

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.01.

b. The standardized statistic is.184.

Q13_2 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q13_2	Yes	Count	21	34	34	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Total	Count	21	34	34	4	93
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	93

a. No statistics are computed because Q13_2 is a constant.

Q13_2 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q13_2	Yes	Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%
Total		Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	92

a. No statistics are computed because Q13_2 is a constant.

Q13_3 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master’s)	Semester modules	Two weeks training	None	Total
Q13_3	Yes	Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	94

a. No statistics are computed because Q13_3 is a constant.

Q13_3 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q13_3	Yes	Count	11	31	29	22	93
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%
Total		Count	11	31	29	22	93

% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	93

a. No statistics are computed because Q13_3 is a constant.

Q13_4 * NQ5

Crosstab

	NQ5				
	Degree (Bachelor's, Honours, Master’s)	Semester modules	Two weeks training	None	Total

Q13_4	Yes	Count	21	34	34	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%
Total		Count	21	34	34	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	93

a. No statistics are computed because Q13_4 is a constant.

Q13_4 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q13_4	Yes	Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%
Total		Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	92

a. No statistics are computed because Q13_4 is a constant.

Q16_1 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_1	Slightly important	Count	0	0	2	0	2
		% within NQ5	0.0%	0.0%	5.9%	0.0%	2.1%
	Fairly important	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%
	Important	Count	3	5	6	0	14
		% within NQ5	14.3%	14.3%	17.6%	0.0%	14.9%
	Very important	Count	17	30	26	4	77
		% within NQ5	81.0%	85.7%	76.5%	100.0%	81.9%

Total	Count	21	35	34	4	94
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.135[a]	9	.521	.417		
Likelihood Ratio	8.772	9	.459	.429		
Fisher's Exact Test	8.026			.633		
Linear-by-Linear Association	.198[b]	1	.657	.677	.370	.076
N of Valid Cases	94					

a. 11 cells (68.8%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is -.445.

Q16_1 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_1	Slightly important	Count	0	0	2	0	2
		% within NQ6	0.0%	0.0%	6.9%	0.0%	2.2%
	Fairly important	Count	1	0	0	0	1
		% within NQ6	9.1%	0.0%	0.0%	0.0%	1.1%
	Important	Count	1	5	4	3	13
		% within NQ6	9.1%	16.1%	13.8%	13.6%	14.0%
	Very important	Count	9	26	23	19	77
		% within NQ6	81.8%	83.9%	79.3%	86.4%	82.8%
Total		Count	11	31	29	22	93

% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	12.243[a]	9	.200	.169		
Likelihood Ratio	9.328	9	.408	.445		
Fisher's Exact Test	7.863			.540		
Linear-by-Linear Association	.035[b]	1	.851	.927	.462	.072
N of Valid Cases	93					

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.187.

Q16_2 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_2	Not important	Count	0	0	2	0	2
		% within NQ5	0.0%	0.0%	6.1%	0.0%	2.2%
	Slightly important	Count	1	1	1	0	3
		% within NQ5	4.8%	2.9%	3.0%	0.0%	3.3%
	Fairly important	Count	2	5	3	0	10
		% within NQ5	9.5%	14.3%	9.1%	0.0%	10.9%
	Important	Count	6	12	9	1	28
		% within NQ5	28.6%	34.3%	27.3%	33.3%	30.4%
	Very important	Count	12	17	18	2	49

	% within NQ5	57.1%	48.6%	54.5%	66.7%	53.3%
Total	Count	21	35	33	3	92
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	5.301[a]	12	.947	.941		
Likelihood Ratio	6.199	12	.906	.953		
Fisher's Exact Test	6.510			.975		
Linear-by-Linear Association	.094[b]	1	.760	.791	.407	.051
N of Valid Cases	92					

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is.07.

b. The standardized statistic is -.306.

Q16_2 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_2	Not important	Count	0	0	2	0	2
		% within NQ6	0.0%	0.0%	6.9%	0.0%	2.2%
	Slightly important	Count	1	1	0	1	3
		% within NQ6	9.1%	3.3%	0.0%	4.8%	3.3%
	Fairly important	Count	2	4	1	2	9

		% within NQ6	18.2%	13.3%	3.4%	9.5%	9.9%
	Important	Count	2	10	9	7	28
		% within NQ6	18.2%	33.3%	31.0%	33.3%	30.8%
	Very important	Count	6	15	17	11	49
		% within NQ6	54.5%	50.0%	58.6%	52.4%	53.8%
Total		Count	11	30	29	21	91
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	9.724[a]	12	.640	.673		
Likelihood Ratio	10.912	12	.536	.703		

Fisher's Exact Test	9.152			.673		
Linear-by-Linear Association	.168[b]	1	.682	.689	.363	.042
N of Valid Cases	91					

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is.24.

b. The standardized statistic is.410.

Q16_3 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_3	Slightly important	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%

	Fairly important	Count	5	3	4	1	13
		% within NQ5	23.8%	8.6%	11.8%	25.0%	13.8%
	Important	Count	5	6	13	2	26
		% within NQ5	23.8%	17.1%	38.2%	50.0%	27.7%
	Very important	Count	10	26	17	1	54
		% within NQ5	47.6%	74.3%	50.0%	25.0%	57.4%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	12.905[a]	9	.167	.134		

Likelihood Ratio	12.227	9	.201	.176		
Fisher's Exact Test	13.820			.091		
Linear-by-Linear Association	.042[b]	1	.837	.874	.450	.062
N of Valid Cases	94					

a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.206.

Q16_3 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_3	Slightly important	Count	1	0	0	0	1

		% within NQ6	9.1%	0.0%	0.0%	0.0%	1.1%
	Fairly important	Count	2	3	5	3	13
		% within NQ6	18.2%	9.7%	17.2%	13.6%	14.0%
	Important	Count	3	8	7	8	26
		% within NQ6	27.3%	25.8%	24.1%	36.4%	28.0%
	Very important	Count	5	20	17	11	53
		% within NQ6	45.5%	64.5%	58.6%	50.0%	57.0%
Total		Count	11	31	29	22	93
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability

Pearson Chi-Square	9.754[a]	9	.371	.373		
Likelihood Ratio	6.566	9	.682	.732		
Fisher's Exact Test	7.139			.670		
Linear-by-Linear Association	.054[b]	1	.816	.835	.435	.054
N of Valid Cases	93					

a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.233.

Q16_4 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_4	Fairly important	Count	0	1	2	0	3

		% within NQ5	0.0%	2.9%	5.9%	0.0%	3.2%
	Important	Count	8	5	10	3	26
		% within NQ5	38.1%	14.3%	29.4%	75.0%	27.7%
	Very important	Count	13	29	22	1	65
		% within NQ5	61.9%	82.9%	64.7%	25.0%	69.1%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.285[a]	6	.113	.117		
Likelihood Ratio	10.608	6	.101	.103		

Fisher's Exact Test	10.034			.072		
Linear-by-Linear Association	1.218[b]	1	.270	.308	.162	.050
N of Valid Cases	94					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.13.

b. The standardized statistic is -1.103.

Q16_4 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master’s)	Semester modules	Two weeks training	None	Total
Q16_4	Fairly important	Count	0	0	3	0	3
		% within NQ6	0.0%	0.0%	10.3%	0.0%	3.2%

	Important	Count	3	5	8	9	25
		% within NQ6	27.3%	16.1%	27.6%	40.9%	26.9%
	Very important	Count	8	26	18	13	65
		% within NQ6	72.7%	83.9%	62.1%	59.1%	69.9%
Total		Count	11	31	29	22	93
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	11.071[a]	6	.086	.083		
Likelihood Ratio	11.421	6	.076	.086		
Fisher's Exact Test	8.472			.131		

Linear-by-Linear Association	2.764[b]	1	.096	.111	.059	.020
N of Valid Cases	93					

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is.35.

b. The standardized statistic is -1.663.

Q16_5 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_5	Fairly important	Count	2	2	1	0	5
		% within NQ5	9.5%	5.7%	2.9%	0.0%	5.3%
	Important	Count	9	11	14	2	36

		% within NQ5	42.9%	31.4%	41.2%	50.0%	38.3%
	Very important	Count	10	22	19	2	53
		% within NQ5	47.6%	62.9%	55.9%	50.0%	56.4%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.621[a]	6	.855	.858		
Likelihood Ratio	2.788	6	.835	.857		
Fisher's Exact Test	3.096			.813		
Linear-by-Linear Association	.450[b]	1	.503	.542	.286	.065

N of Valid Cases	94					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.21.

b. The standardized statistic is.671.

Q16_5 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_5	Fairly important	Count	2	1	1	1	5
		% within NQ6	18.2%	3.2%	3.4%	4.5%	5.4%
	Important	Count	6	11	10	9	36
		% within NQ6	54.5%	35.5%	34.5%	40.9%	38.7%
	Very important	Count	3	19	18	12	52

	% within NQ6	27.3%	61.3%	62.1%	54.5%	55.9%
Total	Count	11	31	29	22	93
	% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.786[a]	6	.341	.348		
Likelihood Ratio	5.857	6	.439	.548		
Fisher's Exact Test	6.263			.352		
Linear-by-Linear Association	1.419[b]	1	.234	.248	.136	.035
N of Valid Cases	93					

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is.59.

b. The standardized statistic is 1.191.

Q16_6 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_6	Slightly important	Count	0	1	0	0	1
		% within NQ5	0.0%	3.0%	0.0%	0.0%	1.1%
	Fairly important	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%
	Important	Count	8	11	17	1	37
		% within NQ5	38.1%	33.3%	50.0%	25.0%	40.2%
	Very important	Count	12	21	17	3	53

	% within NQ5	57.1%	63.6%	50.0%	75.0%	57.6%
Total	Count	21	33	34	4	92
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.381[a]	9	.597	.476		
Likelihood Ratio	7.211	9	.615	.536		
Fisher's Exact Test	9.394			.529		
Linear-by-Linear Association	.015[b]	1	.901	.917	.492	.083
N of Valid Cases	92					

a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.124.

Q16_6 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_6	Slightly important	Count	0	0	1	0	1
		% within NQ6	0.0%	0.0%	3.4%	0.0%	1.1%
	Fairly important	Count	1	0	0	0	1
		% within NQ6	9.1%	0.0%	0.0%	0.0%	1.1%
	Important	Count	5	11	11	10	37
		% within NQ6	45.5%	36.7%	37.9%	47.6%	40.7%
	Very important	Count	5	19	17	11	52

	% within NQ6	45.5%	63.3%	58.6%	52.4%	57.1%
Total	Count	11	30	29	21	91
	% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.452[a]	9	.315	.309		
Likelihood Ratio	7.560	9	.579	.558		
Fisher's Exact Test	8.214			.553		
Linear-by-Linear Association	.017[b]	1	.897	.927	.485	.073
N of Valid Cases	91					

a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.129.

Q16_7 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_7	Slightly important	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%
	Fairly important	Count	3	4	1	1	9
		% within NQ5	14.3%	11.8%	2.9%	25.0%	9.7%
	Important	Count	7	9	13	2	31
		% within NQ5	33.3%	26.5%	38.2%	50.0%	33.3%
	Very important	Count	10	21	20	1	52

	% within NQ5	47.6%	61.8%	58.8%	25.0%	55.9%
Total	Count	21	34	34	4	93
	% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.868[a]	9	.450	.380		
Likelihood Ratio	8.819	9	.454	.455		
Fisher's Exact Test	10.461			.305		
Linear-by-Linear Association	.665[b]	1	.415	.442	.234	.049
N of Valid Cases	93					

a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.816.

Q16_7 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q16_7	Slightly important	Count	1	0	0	0	1
		% within NQ6	9.1%	0.0%	0.0%	0.0%	1.1%
	Fairly important	Count	1	3	3	2	9
		% within NQ6	9.1%	9.7%	10.3%	9.5%	9.8%

	Important	Count	4	9	7	11	31
		% within NQ6	36.4%	29.0%	24.1%	52.4%	33.7%
	Very important	Count	5	19	19	8	51
		% within NQ6	45.5%	61.3%	65.5%	38.1%	55.4%
Total		Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	12.626[a]	9	.180	.166		
Likelihood Ratio	9.407	9	.401	.418		
Fisher's Exact Test	9.877			.313		

Linear-by-Linear Association	.000[b]	1	.989	1.000	.525	.060
N of Valid Cases	92					

a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is -.013.

Q17_1 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master’s)	Semester modules	Two weeks training	None	Total
Q17_1	Not important	Count	0	1	1	0	2
		% within NQ5	0.0%	2.9%	3.1%	0.0%	2.2%
	Slightly important	Count	3	1	1	0	5
		% within NQ5	14.3%	2.9%	3.1%	0.0%	5.4%

	Fairly important	Count	5	5	8	3	21
		% within NQ5	23.8%	14.3%	25.0%	75.0%	22.8%
	Important	Count	5	11	10	0	26
		% within NQ5	23.8%	31.4%	31.3%	0.0%	28.3%
	Very important	Count	8	17	12	1	38
		% within NQ5	38.1%	48.6%	37.5%	25.0%	41.3%
Total		Count	21	35	32	4	92
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	13.074[a]	12	.364	.359		
Likelihood Ratio	12.534	12	.404	.496		

Fisher's Exact Test	11.516			.453		
Linear-by-Linear Association	.070[b]	1	.791	.812	.419	.046
N of Valid Cases	92					

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is.09.

b. The standardized statistic is -.265.

Q17_1 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q17_1	Not important	Count	0	0	1	1	2
		% within NQ6	0.0%	0.0%	3.4%	5.0%	2.2%
	Slightly important	Count	2	1	2	0	5

		% within NQ6	18.2%	3.2%	6.9%	0.0%	5.5%
	Fairly important	Count	1	7	7	6	21
		% within NQ6	9.1%	22.6%	24.1%	30.0%	23.1%
	Important	Count	3	9	8	6	26
		% within NQ6	27.3%	29.0%	27.6%	30.0%	28.6%
	Very important	Count	5	14	11	7	37
		% within NQ6	45.5%	45.2%	37.9%	35.0%	40.7%
Total		Count	11	31	29	20	91
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability

Pearson Chi-Square	8.385[a]	12	.754	.791		
Likelihood Ratio	9.247	12	.682	.811		
Fisher's Exact Test	7.869			.818		
Linear-by-Linear Association	.553[b]	1	.457	.493	.246	.032
N of Valid Cases	91					

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is.24.

b. The standardized statistic is -.744.

Q17_2 * NQ5

Crosstab

NQ5				
Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total

Q17_2	Not important	Count	0	1	1	0	2
		% within NQ5	0.0%	2.9%	3.0%	0.0%	2.2%
	Slightly important	Count	0	0	1	0	1
		% within NQ5	0.0%	0.0%	3.0%	0.0%	1.1%
	Fairly important	Count	2	1	2	1	6
		% within NQ5	9.5%	2.9%	6.1%	25.0%	6.5%
	Important	Count	2	5	10	3	20
		% within NQ5	9.5%	14.3%	30.3%	75.0%	21.5%
	Very important	Count	17	28	19	0	64
		% within NQ5	81.0%	80.0%	57.6%	0.0%	68.8%
Total		Count	21	35	33	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	18.909[a]	12	.091	.116		
Likelihood Ratio	19.896	12	.069	.040		
Fisher's Exact Test	20.597			.018		
Linear-by-Linear Association	5.336[b]	1	.021	.021	.012	.004
N of Valid Cases	93					

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is -2.310.

Q17_2 * NQ6

Crosstab

	NQ6	Total

			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	
Q17_2	Not important	Count	0	1	1	0	2
		% within NQ6	0.0%	3.2%	3.4%	0.0%	2.2%
	Slightly important	Count	0	0	1	0	1
		% within NQ6	0.0%	0.0%	3.4%	0.0%	1.1%
	Fairly important	Count	1	2	1	2	6
		% within NQ6	9.1%	6.5%	3.4%	9.5%	6.5%
	Important	Count	2	6	6	6	20
		% within NQ6	18.2%	19.4%	20.7%	28.6%	21.7%
	Very important	Count	8	22	20	13	63
		% within NQ6	72.7%	71.0%	69.0%	61.9%	68.5%
Total		Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.866[a]	12	.962	.993		
Likelihood Ratio	5.653	12	.933	.994		
Fisher's Exact Test	6.247			.988		
Linear-by-Linear Association	.144[b]	1	.704	.752	.379	.047
N of Valid Cases	92					

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is -.380.

Q17_3 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q17_3	Fairly important	Count	1	0	1	0	2
		% within NQ5	4.8%	0.0%	3.0%	0.0%	2.2%
	Important	Count	4	4	7	1	16
		% within NQ5	19.0%	11.4%	21.2%	25.0%	17.2%
	Very important	Count	16	31	25	3	75
		% within NQ5	76.2%	88.6%	75.8%	75.0%	80.6%
Total		Count	21	35	33	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	3.231[a]	6	.779	.755		
Likelihood Ratio	3.930	6	.686	.789		
Fisher's Exact Test	4.825			.571		
Linear-by-Linear Association	.035[b]	1	.852	.895	.479	.103
N of Valid Cases	93					

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is.09.

b. The standardized statistic is -.186.

Q17_3 * NQ6

Crosstab

	NQ6	Total

			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	
Q17_3	Fairly important	Count	0	0	2	0	2
		% within NQ6	0.0%	0.0%	6.9%	0.0%	2.2%
	Important	Count	3	4	6	3	16
		% within NQ6	27.3%	12.9%	20.7%	14.3%	17.4%
	Very important	Count	8	27	21	18	74
		% within NQ6	72.7%	87.1%	72.4%	85.7%	80.4%
Total		Count	11	31	29	21	92
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.176[a]	6	.404	.407		
Likelihood Ratio	6.395	6	.380	.453		
Fisher's Exact Test	4.890			.542		
Linear-by-Linear Association	.000[b]	1	.992	1.000	.541	.092
N of Valid Cases	92					

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is.24.

b. The standardized statistic is.010.

Q17_4 * NQ5

Crosstab

	NQ5	Total

			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	
Q17_4	Slightly important	Count	1	0	0	0	1
		% within NQ5	4.8%	0.0%	0.0%	0.0%	1.1%
	Fairly important	Count	1	0	1	0	2
		% within NQ5	4.8%	0.0%	2.9%	0.0%	2.2%
	Important	Count	6	6	11	2	25
		% within NQ5	28.6%	17.6%	32.4%	50.0%	26.9%
	Very important	Count	13	28	22	2	65
		% within NQ5	61.9%	82.4%	64.7%	50.0%	69.9%
Total		Count	21	34	34	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.590[a]	9	.476	.383		
Likelihood Ratio	8.731	9	.463	.453		
Fisher's Exact Test	10.576			.289		
Linear-by-Linear Association	.067[b]	1	.795	.835	.439	.081
N of Valid Cases	93					

a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is.259.

Q17_4 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q17_4	Slightly important	Count	0	0	1	0	1
		% within NQ6	0.0%	0.0%	3.4%	0.0%	1.1%
	Fairly important	Count	1	1	0	0	2
		% within NQ6	9.1%	3.3%	0.0%	0.0%	2.2%
	Important	Count	2	8	8	7	25
		% within NQ6	18.2%	26.7%	27.6%	31.8%	27.2%
	Very important	Count	8	21	20	15	64

	% within NQ6	72.7%	70.0%	69.0%	68.2%	69.6%
Total	Count	11	30	29	22	92
	% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.418[a]	9	.697	.762		
Likelihood Ratio	6.590	9	.680	.808		
Fisher's Exact Test	6.458			.804		
Linear-by-Linear Association	.011[b]	1	.917	.927	.494	.072
N of Valid Cases	92					

a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is.105.

Q17_5 * NQ5

Crosstab

			NQ5				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q17_5	Not important	Count	1	2	0	0	3
		% within NQ5	4.8%	5.7%	0.0%	0.0%	3.2%
	Slightly important	Count	3	1	2	0	6

		% within NQ5	14.3%	2.9%	5.9%	0.0%	6.4%
	Fairly important	Count	5	4	7	1	17
		% within NQ5	23.8%	11.4%	20.6%	25.0%	18.1%
	Important	Count	7	14	17	1	39
		% within NQ5	33.3%	40.0%	50.0%	25.0%	41.5%
	Very important	Count	5	14	8	2	29
		% within NQ5	23.8%	40.0%	23.5%	50.0%	30.9%
Total		Count	21	35	34	4	94
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability

Pearson Chi-Square	10.104[a]	12	.607	.615		
Likelihood Ratio	11.091	12	.521	.632		
Fisher's Exact Test	10.730			.520		
Linear-by-Linear Association	1.462[b]	1	.227	.230	.126	.023
N of Valid Cases	94					

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is.13.

b. The standardized statistic is 1.209.

Q17_5 * NQ6

Crosstab

NQ6				
Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total

Q17_5	Not important	Count	1	2	0	0	3
		% within NQ6	9.1%	6.5%	0.0%	0.0%	3.2%
	Slightly important	Count	1	2	3	0	6
		% within NQ6	9.1%	6.5%	10.3%	0.0%	6.5%
	Fairly important	Count	5	4	6	2	17
		% within NQ6	45.5%	12.9%	20.7%	9.1%	18.3%
	Important	Count	2	11	14	11	38
		% within NQ6	18.2%	35.5%	48.3%	50.0%	40.9%
	Very important	Count	2	12	6	9	29
		% within NQ6	18.2%	38.7%	20.7%	40.9%	31.2%
Total		Count	11	31	29	22	93
		% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	17.375[a]	12	.136	.130		
Likelihood Ratio	19.142	12	.085	.129		
Fisher's Exact Test	16.039			.112		
Linear-by-Linear Association	5.345[b]	1	.021	.023	.012	.003
N of Valid Cases	93					

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is.35.

b. The standardized statistic is 2.312.

Q17_6 * NQ5

Crosstab

	NQ5	Total

			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	
Q17_6	Not important	Count	1	1	1	0	3
		% within NQ5	4.8%	2.9%	2.9%	0.0%	3.2%
	Slightly important	Count	0	0	1	0	1
		% within NQ5	0.0%	0.0%	2.9%	0.0%	1.1%
	Fairly important	Count	4	5	6	1	16
		% within NQ5	19.0%	14.7%	17.6%	25.0%	17.2%
	Important	Count	9	10	12	3	34
		% within NQ5	42.9%	29.4%	35.3%	75.0%	36.6%
	Very important	Count	7	18	14	0	39
		% within NQ5	33.3%	52.9%	41.2%	0.0%	41.9%
Total		Count	21	34	34	4	93
		% within NQ5	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.714[a]	12	.807	.795		
Likelihood Ratio	9.360	12	.672	.737		
Fisher's Exact Test	10.275			.684		
Linear-by-Linear Association	.048[b]	1	.826	.849	.439	.049
N of Valid Cases	93					

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is.04.

b. The standardized statistic is -.219.

Q17_6 * NQ6

Crosstab

			NQ6				
			Degree (Bachelor's, Honours, Master's)	Semester modules	Two weeks training	None	Total
Q17_6	Not important	Count	0	1	1	1	3
		% within NQ6	0.0%	3.3%	3.4%	4.5%	3.3%
	Slightly important	Count	0	0	1	0	1
		% within NQ6	0.0%	0.0%	3.4%	0.0%	1.1%
	Fairly important	Count	3	4	5	4	16
		% within NQ6	27.3%	13.3%	17.2%	18.2%	17.4%
	Important	Count	5	12	7	9	33
		% within NQ6	45.5%	40.0%	24.1%	40.9%	35.9%
	Very important	Count	3	13	15	8	39
		% within NQ6	27.3%	43.3%	51.7%	36.4%	42.4%
Total		Count	11	30	29	22	92

% within NQ6	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.633[a]	12	.881	.932		
Likelihood Ratio	7.217	12	.843	.935		
Fisher's Exact Test	7.799			.879		
Linear-by-Linear Association	.015[b]	1	.903	.912	.475	.044
N of Valid Cases	92					

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is.12.

b. The standardized statistic is -.122.

Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
NQ5 * Q19	93	98.9%	1	1.1%	94	100.0%
NQ6 * Q19	92	97.9%	2	2.1%	94	100.0%

NQ5 * Q19

Crosstab

			Q19		Total
			Yes	No	
NQ5	Degree (Bachelor's, Honours, Master's)	Count	20	1	21
		% within Q19	23.0%	16.7%	22.6%
	Semester modules	Count	31	3	34

		% within Q19	35.6%	50.0%	36.6%
	Two weeks training	Count	32	2	34
		% within Q19	36.8%	33.3%	36.6%
	None	Count	4	0	4
		% within Q19	4.6%	0.0%	4.3%
Total		Count	87	6	93
		% within Q19	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.710[a]	3	.871	.913		
Likelihood Ratio	.947	3	.814	.913		

Fisher's Exact Test	.719			1.000		
Linear-by-Linear Association	.031[b]	1	.860	1.000	.528	.191
N of Valid Cases	93					

a. 5 cells (62.5%) have expected count less than 5. The minimum expected count is.26.

b. The standardized statistic is -.176.

NQ6 * Q19

Crosstab

			Q19		
			Yes	No	Total
NQ6	Degree (Bachelor's, Honours, Master's)	Count	10	1	11
		% within Q19	11.6%	16.7%	12.0%
	Semester modules	Count	27	4	31
		% within Q19	31.4%	66.7%	33.7%

	Two weeks training	Count	28	0	28
		% within Q19	32.6%	0.0%	30.4%
	None	Count	21	1	22
		% within Q19	24.4%	16.7%	23.9%
Total		Count	86	6	92
		% within Q19	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.284[a]	3	.232	.221		
Likelihood Ratio	5.681	3	.128	.221		
Fisher's Exact Test	4.224			.200		
Linear-by-Linear Association	1.663[b]	1	.197	.282	.143	.077

N of Valid Cases	92					

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is.72.

b. The standardized statistic is -1.289.

Annexure 4.2 Knowledge areas and skills survey participants would like to improve in order to function more effectively.

Q10 - If you could do more courses in GIS and or remote sensing, which knowledge areas or skills would you like to improve in order to function more effectively? Mention at least three important areas for you.

Knowledge of GIS	Basic GIS, any aspect of GIS
Cartography (2) / Making and analysing maps (20)	Understanding scale on maps
How to use geographic information (19)	Use and interpret different GIS systems/programmes, understanding how to use GIS layers more efficiently, how to use GIS tools
Interpretation (13)	
Mapping spatial data and producing maps	Plotting information into cadastral map. GIS Mapping, Georeferencing
Understanding GIS maps layers more efficiently	
Remote sensing (13)	
Spatial Analysis	Terrain analysis, environmental spatial analysis, image analysis and interpretation, Spot 5 Image analysis, data analysis, analysis and manipulation of spatial information.
Knowledge of spatial operations	Measurements, classification, Identify (7) Sensitivities on site with Listing Notice 3 (LN 3) Identify approved development as per EIA issued sensitive areas, Identify sensitive areas such as vegetation, watercourses, wetlands

Databases (3)	Geographical database for EA's issues and creating a database for projects.
Processing digital images (2)	
Basic programming knowledge	
Developments in GIS	My theoretical and practical knowledge of GIS and remote sensing extends to basic concepts and applications of both aspects. Continual training in both aspects is necessary to facilitate knowledge of emerging trends and enhance my contribution towards GIS management at a local, provincial and national scale.
Manipulating data (3)	
Knowledge about software types (Software 7)	Mastering the usage of ArcGIS software for analysis and interpreting data, as this type of software seems dominant on the market. ESRI
Critical thinking (2)	
Application of Vector and Raster data in GIS	
Geocoding	
How to do buffer zones	
Better decision-making	Make better informed decision using an updated system reflecting accurate changes especially in Gauteng province region
	Cost saving when it to future planning versus saving the environment
Capacity building	Refresher training / continual training
Modelling	
Images	Historical comparison of images

Annexure 4.3 Academic documents on the use of geographic information in EIA review

Title	How to get hold of it
Integrating Sustainability and Environmental Impact Assessment DAVID P. LAWRENCE Environmental Management Vol. 21, No. 1, pp. 23 – 42	(Your university journal search database)
Master Dissertation: Geographical Information systems for environmental assessment: a feasibility study (2014)	
Appendix 4(1)(1)(c) of the EIA Regulations, 2014 as amended.	
The screening tool	
North West Biodiversity Sector Plan 2015	
NEMA Regulations (2014) makes provision for the use of the Environmental Screening Tool.	The Environmental Screening Tool is GIS Web-based tool.

Any Environmental Authorisation	
GPEMF and Gauteng province Conservation Plan version 3.3	
The Mpumalanga Biodiversity Plan, (Mpumalanga Tourism Parks Agency)	
	https://www.worldscientific.com/doi/abs/10.1142/S146433321250007X https://iopscience.iop.org/article/10.1088/1755-1315/127/1/012009 http://www.iosrjournals.org/iosr-jestft/papers/vol8-issue12/Version-2/E081223239.pdf Additional input can be sourced locally via engagement with professional registration bodies for spatial information management: http://gissa.org.za/activities/government/government-institutions
The interviewee couldn't remember the title of the document	The interviewee provided the names of people whom she knew wrote about what I was looking for.

Annexure 5.1 Responses from interviewees regarding knowledge areas required

Question 10. If you could do more courses in GIS and or remote sensing, which knowledge areas or skills would you like to improve in order to function more effectively? Mention at least three important areas for you.

Knowledge areas	Description / Quotations from interviewees
GIS concepts	
Modelling	
Data capturing	Use of GPS, digitising
Field data collection	This is about collecting data on a site proposed for development. This is helpful in cases where one needs to measure the size of the proposed development as the size determines whether the proposed development requires environmental authorisation or not (activity is listed or not).
Data analysis	“With analysis, you can extrapolate information from data layers, instead of just looking at it, you can manipulate it to get information in graphs, spread sheets or whatever case may be information out in graphs or spreadsheets or whatever the case may be”.
Interpretation	To be able to interpret findings of the study on my own
Image interpretation	Satellite photographs.
Spatial Analysis	Specific reference was made about understanding Listing Notice 3 because one needs to use GIS to confirm if the activity falls within the sensitive area specified in Listing Notice 3. 6 interviewees mentioned Listing Notice 3.
	It would help to have a GIS tool that will assist us to analyse environmental sensitivity of the area for it to be in our exposure and be able to use it to verifying the activities, if they indeed are triggering that listed activity because it could be very tricky with all the aspects that come with Listing Notice 3. Like it is difficult to know the ecological status of all the areas that you are working under without the tool being there to be able to assist you. Although I don't know how GIS works, but we need it for the Listing Notice 3 - we need a GIS tool to assist us to verify activities, to analyse sensitive areas. To capture data in a GIS, to find those records, to keep those records, because the records do somehow get lost in the system if you don't have an organised system. I think GIS can also be able to assist in that manner, although I’ve really said I don't know how GIS really works but I think if there is

	anything that GIS can offer in that regard, it could be helpful as well. As well as analysing environmental sensitivity of the area in order to make a decision.
Introduction to GISc	Basic map skills, understanding features, producing maps, interpreting maps. This is important to understand the features of a site, if it is sensitive or not (if it appropriate for the proposed development)
Basic spatial operations	As someone with no education in GIS and with the knowledge I have I would still like to get training on GIS course that will assist me to identify the current situation on the ground. Identify the amount of biodiversity (Flora) in the proposed site. That will assist me in making more informed decisions. May be in future it will motivate my interest in doing research and assist with desktop studies
Managing and manipulating digital geographic information for the project	
Creation and production of maps	How to open a map. How to query, how to find sensitive areas in an application. To be able to print that map and mail that page to the applicant)
Using GIS tools	Interviewees, even those who have not used, the emphasis was on, just the basics
The ability to use geoprocessing tools	Processing, geoprocessing tools in ArcMap. With geoprocessing tools, you are able to make buffers for important areas, they help you to assess the area better, interpret what you see. You can look even more data, elevation data you assess the area before you go on site.
Creation and querying of spatial databases	
Mapping	Map design, analysis of maps, basic map skills
Remote sensing	Need more remote sensing training as we now have web-based systems
GIS workflow	
Refresher on presentation of maps	

Advanced training, to keep abreast of changes	
Knowledge about features in ArcGIS	I need to know about the features that they add in ArcGIS. Once or twice a year we can go for a workshop. A course that can help in decision-making.
Populating	

Annexure 5.2 Interviewees' responses regarding specific areas in an EIA process where geographic information is used

Question 15. In your actual review of EIAs, how are you using geographic information, or in which specific areas in the assessment process, are you using geographic information?

Stage of EIA process	How is geographic information used
To respond to enquiries	To confirm if the activity is listed or not. To check proximity of the proposed development to any sensitive areas (such as protected areas, rivers, type of vegetation) and any other features such as dolomite and slime dams).
Screening	To identify if the EIA is required. To scope the issues. To determine the significance of the impacts. To see the spatial extent of the area.
Pre-application / Application stage (In preparation for a site visit)	To confirm location. Check features (sensitivity) of the site. After confirming this then the actual review of the content can start.
	To check compatibility of the proposed development with the site by checking the site sensitivity.
	Going to site visit you see what your eye can see unlike checking the map.
	When you get an application. Before you go to site you check the map. When you get to site you compare. We use it to verify information.
	I use web-based system to get information like cadastral information as it is not catered in the Screening Tool developed by the department
	I use Google Earth to understand the history pattern of the area where there is a proposed development.
	To confirm if the developer has not commenced with the development prior the authorisation. Google Earth, satellite photographs are used to check if there isn't any illegal clearance of vegetation.
	To identify biodiversity features (e.g. vegetation type)

Pre-application / Application stage (In preparation for the meeting in order to advise the EAP consultant)	It gives you a nice background. It gives you an aerial view of the areas, then you prepare better, like understanding vegetation, soil, agriculture, etc. All this information helps you to have a fruitful discussion with the applicant / EAP
Site visit stage	Compare, verify, ground truth
Review stage	When you review the report, you go back and compare what geographic information (e.g. SANBI) says, e.g., confirm vegetation name, is the area protected or not?
Preparation for a decision	Also, when you present to the team that makes a decision you show what the map is saying and what is happening on site.

Annexure 5.3 Interviewees' responses regarding how is geographic information helping review work and decision-making.

Question 16. So, ever since you started, how is it helping your review and decision-making work?

(Most respondents were repeating their responses in question 15. Therefore, most responses in question 16 are similar to the responses in question 15. So the responses here confirm or augment the information provided in question 15) So it shows the advantage of qualitative methods because you can ask the same thing in different ways and you then see if you still get the same answers).

To verify information submitted by the consultant.

Take pictures on site and then when you come back you geo-tag them, this will help to get a better understanding of the site information and compare the information in the report and what you actually saw on site.

Geographic information helps you to see the features of the site. After that you are able to determine the mitigation measures. For example, if there is a housing development and then there are wetlands, rivers nearby, you are then able to determine mitigation measures.

Geographic information helps you to prepare for the site visit. It tells you what is on the ground. By the time you get to the site you know what to look for.

To find areas quickly. To find certain information quickly than ever before, that is why I am saying GIS and remote sensing are very important.

It makes it easy to understand the area. It guides the application like which areas are sensitive and which ones are not. It can lead to the amendment of the layout plan for the development.

Buffers can be determined.

Geographic information is very useful. At least you have a legal document (Biodiversity Sector plan) to base your decision.

To see the location of the proposed development, where they have applied.

I use web-based system to get information like cadastral information as it is not catered in the Screening Tool.

I use Google Earth to understand the history pattern of the area where there is proposed development.

It is a useful tool. It would indicate the conservation level of that site and coupled with information submitted with the report and it assists in the decision-making.

Features that officials are normally concerned about in the review process, as they were mentioned repeatedly are vegetation, protected areas, and groundwater.

Faster decision-making and saves time: Access to geographic information helps us to confirm things ourselves. We no longer have to transport files to another office to get comments from biodiversity section which is located hundreds of kilometres away. We can see that the proposed site is within or outside the critical biodiversity area. So, we are now able to cut that 40 or 50 days of referring the file to another section.

Geographic information informs you on the site-specific attributes. It is impossible to walk the entire site.

We use it as a guide to get a sense of what are the site-specific attributes.

And then one takes it a step further. What are the ecological processes that operates on that subject property besides the vegetation or the river or the wetland feature that occur on the property? Surely the ecological processes that are being driven now at the same time, now often those things often extend beyond the cadastral boundaries of the property. So you need to consider impacts on this property but in terms of the ecological processes that go beyond the footprint of either the site that will be developed or the property. That steers us in the direction of having to consider cumulative impacts, for example, the extraction of water taking place on the property to build the dam, that river which flows through the subject property it goes through the property, it goes downstream where there is also other land uses so what will be the impact of now building a dam on this property extracting so much water or keeping so much water back? How will it affect other downstream users? How will it affect the ecological processes downstream? If you extract too much water, then it will have an effect on the ecology further downstream that actually needs that water in the ecological reserve. That is why I'm saying we use the attributes of the property which extend beyond the cadastral boundaries of the property. Those are the things which will then guide our decision-making.

Geographic information provides you with information that extends beyond the boundaries of the proposed site. For example, biodiversity corridors. In terms of the EIA process, such information is very important because it assist to determine the nature of the assessment that must be undertaken.

Geographic information is helpful. Other interviewees were saying geographic information is helpful, but they were also very quick to raise concerns

It is helping to a little extent. Maps do not tell you the site-specific area. It shows you a broad idea.

It helps me to confirm what the EAP is saying but it is challenge because the Biodiversity Sector Plan (BSP) can say the place is a critical biodiversity area (CBA) when it is no longer a CBA anymore. So when you go on site it is not what is on the BSP. So we also rely on EAPs to get better information from the other commenting authorities.

Annexure 5.4 Interviewees' responses on challenges regarding use of geographic information in EIAs

Question 17. Any challenges or disadvantages?

Categories	Description / Quotations from the interviewees
Lack of high processing computers	Lack of proper computers. In some cases, there is only one computer with the software and then there is a queue. This is a challenge because EIAs have timeframes
Time	One example the interviewee provided was the time it takes to geo-tag pictures and create a map and link to your report. The EIA has timeframes that you must meet, so you end up not being able to use those pictures and create a map because it takes time.
Access to the software	Only certain people (GIS personnel) have it. You need permission to get it and it is very expensive. When you request software, you are told it is expensive.
	There are free softwares that one can download but even that you need IT permission. It takes time to get that approval.
	There are different systems (SANBI, DEA e-GIS), now the interface is not the same.
Challenges with Google Earth maps	Outdated maps especially in rural areas. Some consultants submit Google maps, it is nice but in rural areas it is not updated. Many times you go to site and it is not the same as what you see in the Google map.
Lack of technical expertise / knowledge	Inability to interpret the geographic information. Lack of technical expertise.
Lack of training	Officials do not have background knowledge about how to use geographic information
IT challenges	We also need IT people because there are some technical problems. So they need to be available as back-up. We need people to monitor the system.
	Network problems. Sometimes the network is slow or not even there. Sometimes the network problem is beyond the GIS technician. Sometimes technicians respond after 2 days whereas the EIA has timeframes.
	When updates are done, this can be confusing to someone not familiar with IT issues
	Heavy reliance on one GIS personnel in offices where officials are not able to interpret geographic information themselves – again emphasis is that EIA has timeframes, so you end up not being able to make use of geographic information.
Outdated geographic information	Since some of the data sources are outdated (Google maps, Biodiversity Plans), officials have to find other ways of verifying. Like using difference sources of geographic information (Biodiversity Sector Plan and the

	Screening Tool); Biodiversity Sector Plan and Google Earth Map; site visits.
	Outdated data causes delays. Specialist reports are then required to get to a conclusion
	Sometimes you cannot depend on it 100%. Ground truth needs to be done in any way. If we can reach a stage where we say information is reliable, there you can make a decision that can be fine. We need to get to a stage where it is regularly updated, it is reliable information, like 80 or 90% is reflecting the site as it is.
Concern about accuracy of information	Hence the need for site visit and ground truth. GPS is used to collect geographic information on the actual site.
Lack of other important geographic information important in EIA review and decision-making	We do not have other data such as industries, sewerage, noise and smells. Screening tool does not have details.
	It doesn't really speak to other issues such as socio-economic issues, where one can use the system to inform the aspects such as of need and desirability of a proposal. Because now we've got one leg which is the environmental leg, which represents one of the components of the environment, but clearly there is another leg, the socio-economic component. The screening tool places more emphasis on the environmental component. And now you have EAPs submitting those reports, which gives the green light in terms environment. Yes, environmentally you can actually go ahead with this development but that still needs to be subjected to the socio-economic impact of the proposal. I think what we're looking for is all in one GIS system information that that also reflects the socio-economic aspects. And if that those layers can be incorporated or integrated into the systems. I think one will then be able to see the full picture and how things balance.
People issues	Concerns about Senior Manager's understanding of the value of geographic information
	Politics
	Lack of funds to provide resources (software, data, high processing computers).
	Organisational issues like procedures to get approval for the software.

Annexure 5.5 Interviewees' responses about what does it take to use geographic information

Question 18. In your understanding what does it take to be able to use geographic information in EIA review?

Capacity building in different forms: Training, refresher training, awareness sessions, information sharing, workshops.

Awareness sessions to cover, the benefits of using geographic information in EIA review and decision-making. Because if they are uncomfortable to use the system, they will be reluctant to use it.

Training to cover: Knowledge of how to use authentic information, how to collect data, interpret maps, how to use different databases (e.g. Biodiversity Sector Plan and Google Earth) to confirm or verify information, how to use different software types.

Technical skills, how to use the system.

To collect data for the project, like data from the site visit

How to capture that data into the computer when you are back in the office

Manipulating digital geographic information for the project

How to access various geographic information that is required in an EIA review.

Software

Knowledge of the software types

Ability to use different software types

Officials need to have software in the computers

Geography background

Basic GIS – Basic understanding of GIS how to query, produce maps and send to the applicant.

Creation and production of maps (How to open a map. How to query, how to find sensitive areas in an application. To be able to print that map and mail that page to the applicant)

Analytical skills – The ability to look at the geographic information and question it, what does this tell me.

Practice often, the more you are exposed to it, the more you are able to use it.

Computer skills

Legislative measures - To make it a requirement in the regulations.

IT issues – network needs to be available because you need data quickly as EIA has timeframes

Personal interest in geographic information

Support from the Supervisors

Learn from other countries

Sharing information within the country

Annexure 5.6 Interviewees' responses about geographic information competencies required in order to review EIAs

Question 19. In your understanding, what are the geographic information competencies that are required in order to review EIAs?

Geography

Map reading

Interpretation

Environmental science

Knowledge about ecology

GIS knowledge (Introduction to GIS)

Map reading

Interpretation

Data acquisition

Vegetation classification - to classify the slopes and vegetation that happen in that particular place. In EIA, geographic information should be used to check the appropriate slopes for development. For nature conservation, it will be good as a management tool for burning purposes. We can use GIS to check which methods to use for burning whether we use helicopters or man / people.

Spatial data analysis

Map production

Database management

Practical knowledge

How to draw measurements

How to identify features

How to draw boundaries

How to use GIS tools

How to collect data using GPS

Digitising

Application of spatial knowledge

What kind of layers would be required for an EIA and how to access them? Layers such as archaeology, biodiversity, air quality, waste, social issues.

Analytical methods – basic analytical methods query, identify, query, to check site sensitivity.

Map production, in relation to Listing Notice 3 or in preparation for site visit.

Critical thinking skills

Knowledge about other related courses

Computer skills

Mathematics

IT - Knowledge about IT issues (networks, software types)

Processing and manipulation for a specific EIA.

The content of the course needs to cover GIS and EIA related issues. In terms of the EIA process, an applicant could be applying for a development (development of a mast or tower, road, resorts, hotels) within a specified geographical area (critical biodiversity area, World Heritage site, and protected area in terms of Protected Areas Act). Sometimes officials need to determine whether the applicant needs an environmental authorisation or not. So they need to have technical knowledge and skills about how to use geographic information in order to make that determination. Officials need to capture the coordinates of the site, measure the size of the proposed site, check its proximity to the sensitive area, and manage the quality of that data.

Qualification - Other interviewees mentioned qualification level for GIS should be a Diploma or Degree).

Training (Accredited training or short courses in GIS)

Both GIS and Environmental management – "Practical knowledge of environmental management and the EIA process. It has to be done as early as possible at varsity. So students can go through the normal module of GIS, but they need to have practical side of the tool in the EIA, practical application in the EIA review, that, practical aspect needs to come from the university. So there could be a case study that students work on, they look at a particular site, they screen that site to determine the impacts so that when they become practitioners, they know this is how the tool is applied".

Annexure 5.7 Responses: What can be done to encourage its use by officials?

Question 20. Knowing the importance of geographic information in the EIA, what can be done to encourage its use by officials?

Capacity building	Accredited training / Short Training / Refresher training / Workshops, webinars, awareness campaigns, information sharing, provide pamphlets, booklets, short courses
	Benefits of using geographic information in EIA review and decision-making to stimulate interest. Officials need to be told about the importance of geographic information. For example, they need to be presented with the Conservation Plan (C-Plan) so that they can see the value of information it provides. Developers of geographic information must train end-users. Make information sharing a norm. Training about basic knowledge of geographic information Short training sessions even in the office. Such training must cover practical assignments. Get experts to show the true value of geographic information. Practice often
Attend GIS Open Days organised by DEA.	Need to encourage officials to attend GIS days, they will learn about developments in geographic information and the variety of things that you can do with it. “Because it's not only about maps and drawing up maps but there's so much you can do with it. And the way it has evolved in the last couple of years, people are doing like emergency exits from a search from a town with GIS. You can design railways, roads with GIS, it’s not normal maps anymore with it now. Give people more access, show them, and tell them. It’s not just about maps. There will be interests. The keynote speaker in the GIS Day, showed things that I didn't think GIS can do”.
People issues	Senior Managers need to open training opportunities. They need to see the benefits of using geographic information.
	Managers in the EIA section need to make sure that officials, as part of submitting the recommendation for the decision for signature, they also

	include a mandatory GIS review report. This will compel officials to make use of geographic information.
	End-users must keep a good relationship with developers of geographic information. Like getting their contact details and contact them if there is a need.
Legislative measures	Make the use of geographic information a requirement in the regulations.
	Other interviewees (2) felt that the inclusion of the screening tool in the EIA regulations forces officials to use geographic information. So it is up to officials to make use of it.
Provision of resources	"It is discouraging to attend the course and you come back to the office there are no resources"
	Provide the software for each official as opposed to one computer in the whole office.
	Each computer to have all the geographic information that are required.

Annexure 5.8 Responses from interviewees regarding the legislation and the use of geographic information by EIA officials

Question 18: **How well do you think the legislation deals with the use of geographic information by officials reviewing EIAs?**

The regulations already deal with the use of geographic information by officials

There is a section in the legislation that speaks to tools. So, screening tool has been gazetted. So officials need to make use of geographic information provided in the screening tool.

The legislation regulates what the consultant must do. Nothing with respect to officials

There is guidance to EAPs.

NEMA is clear about which coordinates to use. Because previously, people were just putting coordinates but when you look in the system those coordinates are in the sea. That side is talking to consultants. Nothing really to officials. However, if we look at the screening tool that is developed by the department at the moment as they say it is not for us, however, we can verify the information and check if you come up with the same conclusion. Information is very minimal. It is a start of it. We need more, it needs to be at a higher level. We need to move to digital anyway. So I think when we start moving to digital, we'll start increasing the use of GIS and be more specific and more advanced to it. We are very far behind because we are not using the geographic information optimally yet.

The legislation does not say anything.

No clarity, you end up assuming, not enough direction.

Not clear, the link between EIA and geographic information needs to be strengthened.

No guidance, except that Listing Notice 3 shows that you have to make reference to GIS.

Not specific, reason being we are not really on to it too much.

It doesn't elaborate on the use.

The regulations are not clear.

It doesn’t tell me. It is not a requirement.

I don't think it is clear.

Not clear

I don't remember where it is in the legislation.

Annexure 6: Programmes for GIS Days from 2017 to 2020

DEA GIS DAY 2017 – 14 - 15 NOVEMBER

14 NOVEMBER 2017

TIME	EVENT	PRESENTER
09:30 – 10:00	REGISTRATION	
10:00 – 12:00	Workshop 1: "The History of Maps"	Ms Cecily van der Berg (DEA)
	Workshop 2: "Dashboards and Reporting a Dashboard"	Mr Rudolph de Munnik (ESRI)
	Workshop 3: "GIS live @ DEA"	Ms Marlanie Moodley (DEA)
	LUNCH: 12:00 – 13:00	
13:00 – 15:00	Workshop 1: "The History of Maps"	Ms Cecily van der Berg (DEA)
	Workshop 2: "Dashboards and Reporting a Dashboard"	Mr Rudolph de Munnik (ESRI)
	Workshop 3: "GIS live @ DEA"	Ms Marlanie Moodley (DEA)

15 NOVEMBER 2017

TIME	EVENT	PRESENTER
08:00 – 08:30	REGISTRATION	
08:30 – 09:15	MASTER OF CEREMONIES: Ms Cecily van der Berg WELCOME AND OPENING: Ms Dee Fisher KEYNOTE ADDRESS: Dr Ven Pillay	
09:15 – 10:45	09:15 – 09:45: "National Spatial Economic Opportunity Atlas"	Ms Enkosi Mpondo (DRDLR)
	09:45 – 10:15: "How GIS has supported the Working for Water Programme"	Mr Andrew Wannenburgh (DEA)
	10:15 – 10:45: " Advanced Fire Information System supporting fire control"	Ms Linda Kleyn (CSIR)
10:45 – 11:00	TEA	
11:00 – 12:30	11:00 – 11:30: "Integrating GIS and remote sensing to assist communities in *Lantana camara* clearing"	Dr Zakariyyaa Oumar (DEA)
	11:30 – 12:00: "A New Generation of Landscape Mapping & Monitoring for South Africa"	Mr Mark Thompson (Geo Terra Image)
	12:00 – 12:30: "Remote Sensing, enhancing the Community"	Mr Michael Breetzke (Swift Geospatial Solutions)
12:30 - 13:30	LUNCH	
13:30 – 14:45	13:30 – 14:00: "Capacitating you through Screening"	Ms Marlanie Moodley (DEA)
	14:00 – 14:30: "Dwelling Frame for STATSSA"	Mr Dean McCormick (Hexagon)
	14:30 – 15:00: "The GIANT Flag - A Legacy Project of Vast Proportions"	Mr Nisbert Chimboza (Geo Data Design)
15:00 – 15:30	DISCUSSION SESSION	

THANK YOU FOR ATTENDING GIS DAY 2017

GIS Day

DEA GIS DAY 2018 – 15 NOVEMBER 2018

PROGRAM

TIME	EVENT	PRESENTER
08:00 – 09:00	REGISTRATION	
09:00 – 09:30	**WELCOME AND OPENING:** Dr Zakariyyaa Oumar KEYNOTE ADDRESS: Mr Peter Lukey	
09:30 – 10:45	09:30 – 10:00: "The changing nature of GIS (The last 25 years)"	Mr Marius Burger (ESRI)
	10:00 – 10:30: "What's next?"	Ms Liezel Botha (ESRI)
	10:30 – 10:45: VIDEO PRESENTATION	
10:45 – 11:00	TEA	
11:00 – 12:30	11:00 – 11:30: "GIS Application in Weather and Climate within the South African Weather Service."	Dr Abiodun Adeola & Mr Musa Mkhwanazi (South African Weather Services)
	11:30 – 12:00: "Advancement of biodiversity data sets and assessments using Geospatial Technologies"	Kedibone Ndlovu (SANBI)
	12:00 – 12:30: "Positioning South Africa for Results Oriented Earth Observations"	Ms Andiswa Mlisa (SANSA)
12:30 - 13:30	LUNCH	
13:30 – 15:30	13:30 – 13:45: VIDEO PRESENTATION	
	13:45 – 14:45: 'Drone survey & mapping: Photogrammetry vs Lidar'	Mr Norbert Plate (iQ Laser)
	14:45 – 15:15: "Demonstration of the National Screening Tool"	Mr Deon Marais (DEA)
	15:15 – 15:30 **Discussion Session**	Questions and answers from the audience.
15:30	CLOSING OF EVENT	

THANK YOU FOR ATTENDING OUR GIS DAY 2018

GIS DAY 2019 – 13 NOVEMBER 2019
EVENT PROGRAM

"GEOSPATIAL TECHNOLOGIES: SUPPORTING OUR CHANGING ENVIRONMENT"

TIME	*EVENT*	*PRESENTER*
08:00 – 09:00	**REGISTRATION: Fortis Hotel Capital, 390 Lillian Ngoyi Street, Pretoria**	
09:00 – 09:30	**WELCOME AND OPENING:** Dr Zakariyyaa Oumar (MC) **KEYNOTE ADDRESS:** Mr Stuart Martin (ESRI)	
09:30 – 10:45	09:30 – 10:00: "The Heroes Map"	Mr Rudolf de Munnik (ESRI)
	10:00 – 10:30: "Working on Fire - Working for the Future"	Ms Colette van Rooyen (WoF)
	10:30 – 10:45: VIDEO PRESENTATION	
10:45 – 11:00	TEA	
11:00 – 12:30	11:00 – 11:30: "Oceans and Coastal Information Management System"	Ms Riette Pretorius (CSIR)
	11:30 – 12:00: "Air Quality Information Tools in South Africa: Geospatial Technologies"	Ms Patience Gwaze (DEFF)
	12:00 – 12:30: "GIS and the National Biodiversity Assessment: the crucial role of spatial data collection, management and analysis."	Ms Sediqa Khatieb (SANBI)
12:30 - 13:30	LUNCH	
13:30 – 15:30	13:30 – 13:45: VIDEO PRESENTATION	
	13:45 – 14:45: "Introducing South African National Land-Cover 2018 and the associated Change Detection datasets"	Mr Mark Thompson (GTI - GeoTerraImage SA)
	14:45 – 15:15: "Decision Support tools: NSPDR & SLL tool"	Mr Mfanafuthi Gama (DRDLR)
	15:15 – 15:30 Discussion Session	Questions and answers from the audience.
15:30	**CLOSING OF EVENT**	

THANK YOU FOR ATTENDING OUR GIS DAY 2019

GIS Day

DEPARTMENT OF ENVIRONMENT; FORESTRY & FISHERIES

PRESENTS

"GIS AND COVID 19 - VALUABLE TECHNOLOGY IN A TIME OF CRISIS"

TIME	PRESENTATION	PRESENTER
09:45 – 10:00	Opening & Welcome	Marlanie Moodley (DEFF)
10:00 – 10:30	"GIS in a time of crisis"	Stuart Martin (ESRI-SA)
10:30 – 11:00	"The value of GIS for an urban observatory: the case of the GCRO"	Gillian Maree (GCRO) & Samkelisiwe Khanyile
11:00 – 11:30	"The value of a GIS platform"	Rudolf de Munnik (ESRI-SA)
11:30 – 12:00	"The COVID 19 Effect: Crime Statistics Within The Free State Province"	Cecily van der Berg (DEFF/SAPS)
12:00 – 12:25	VIDEO: "GIS in a time of COVID"	
12:25 – 12:35	DISCUSSION	
12:35	CLOSING. THANK YOU FOR ATTENDING THIS EVENT!	