



**A SKILLS DEVELOPMENT STRATEGY FOR A SELECTED TECHNOLOGY
COMPANY IN THE NORTHERN CAPE**

by

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DECLARATION

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ABSTRACT

This study aimed to assess the effectiveness of a skills development strategy for the Square Kilometer Array (SKA) radio telescope, a global technology project based in the Northern Cape, South Africa. This project has the potential to benefit local communities around the Karoo. Projects like it are often associated with social impacts and involvement of local communities increases the likelihood of success. The study applied interpretivism skills development philosophies that involved using semi-structured questionnaires to assess how effective the skills development programmes currently being implemented by the National Research | Foundation South African Radio Astronomy Observatory NRF|SARAO are and their impacts on operations of the SKA. The questionnaires were administered to 17 members of communities in the Karoo region to determine their awareness of SKA programmes, willingness to participate in the SKA programmes and factors that affect implementation of the programmes. The findings indicated that communities were aware of the programmes the NRF|SARAO being implemented. These include bursaries that support students from primary school up to graduate level as well as artisan training, which potentially benefits mainly the youth of the Karoo. Communities had varying responses concerning the effectiveness of the programmes, with most respondents (35.3%) regarding the programmes as neither effective nor non-effective. Regarding the strengths and weaknesses of the programmes offered by the NRF|SARAO, the percentage of strengths were rated at 43.5% and weaknesses at 56.5%. Weaknesses mainly had to do with how the SKA programmes are being implemented, which is discriminatory to potential candidates, and communities end up disregarding them. Various hindrances that derail the progress of the programmes and their successes were raised, which had to do with the communities themselves, their perceptions, and standards set by the SKA which, at times, hinder potential candidates from taking up the programmes. This study noted major challenges associated with the SKA project in the Karoo region. It is important to document and understand these issues deeply in order to promote a harmonious atmosphere with both the communities and the SKA benefiting. The weakness to strength ratio of programmes offered by the SKA project should be very low with strengths dominating more than the weaknesses. It is up to the SKA to look at the weaknesses, address them and reach out to the community. The

strengths should also be assessed so that the effectiveness of programmes is enhanced.

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TABLE OF CONTENTS

DECLARATION.....	ii
ABSTRACT.....	iii
DEDICATION.....	vi
TABLE OF CONTENTS.....	vii
LIST OF FIGURES.....	xi
LIST OF TABLES.....	xii
LIST OF APPENDICES.....	xiii
CLARIFICATION OF KEY CONCEPTS.....	xiv
ABBREVIATIONS.....	xv
CHAPTER ONE.....	1
1.1 Introduction.....	1
1.2 Background to the study.....	2
1.3 Problem Statement.....	3
1.4 Significance of the study.....	3
1.5 Aims and objectives of the study.....	4
1.6 Research questions.....	4
1.7 Propositions.....	4
1.8 Definition of key concepts.....	5
1.9 Limitations of the research.....	5
1.10 Delimitations of the research.....	6
1.11 Outline of dissertation.....	6
1.12 Chapter summary.....	6
CHAPTER TWO.....	7
LITERATURE REVIEW.....	7
2.1 Introduction.....	7

2.2	The SKA project	7
2.3	The SKA project and local community development	8
2.4	Other global projects	10
2.5	Skills shortage in South Africa	11
2.6	Skill development strategy requirement - future/desired.....	14
2.7	Retention of experience personnel	14
2.8	National qualifications framework	15
2.8.1	Importance of skills transfer in engineering and technology	15
2.9	Impact of skills development programme at NRF SARAO – present.....	16
2.10	Imperative of skills transfer and retention in the Karoo	17
2.11	Career planning and professional growth	18
2.12	Employee turnover in engineering and technology firms	18
2.13	Working conditions.....	19
2.14	Effectiveness of skills development programmes by NRF SARAO	20
2.14.1	Capacity to aspects of programme development.....	21
2.14.2	Market opportunities for NRF/SARAO	21
2.15	Digital converters and wireless communication	22
2.15.1	Developments that were used for ICT	22
2.15.2	What constitutes design and development?	23
2.16	Summary.....	23
CHAPTER THREE		24
RESEARCH DESIGN AND METHODOLOGY		24
3.1	Introduction.....	24
3.2	Study area	24
3.3	Framework proposal sustainability	25
3.4	Skills development philosophy.....	25
3.4.1	Research paradigm and philosophy positivism	26
3.5	Skills development methodology	26
3.5.1	Questionnaire skills development approach.....	27
3.6	Skills development design	27
3.6.1	Skills transfer and retention in engineering and technology	29

3.6.2	A mixed study for skills development study	29
3.6.3	Methods for data collection.....	30
3.6.4	Primary data collection: Interviews	30
3.6.5	Interpretation and questionnaire data analysis	31
3.6.6	Interview guide: pilot testing	32
3.7	Sampling	32
3.7.1	Target population	32
3.8	Data analysis	33
3.8.1	Validity.....	34
3.8.2	Prevention of bias.....	34
3.9	Ethical considerations.....	34
3.10	Summary.....	35
CHAPTER FOUR.....		36
RESULTS.....		36
4.1	Introduction.....	36
4.2	Demographic details.....	36
4.2.1	Gender	36
4.2.2	Age group.....	37
4.2.3	Qualifications.....	38
4.3	Questionnaire responses.....	39
4.3.1	Development that can be done in the Karoo	39
4.3.2	What type of skills does NRF SARAO need in the Karoo?.....	40
4.3.3	HCD programmes that the NRF SARAO is implementing in the Karoo.....	41
4.3.4	Reasons skills development HCD programmes were developed	41
4.3.5	The main beneficiaries of HCD programmes.....	42
4.3.6	How the programmes work.....	43
4.3.7	How effective have these programmes been in fulfilling their objectives? ...	44
4.3.8	Strengths and weaknesses of the skills development programmes	45
4.3.9	Factors that have hindered the effectiveness of these programmes	48
4.3.10	What the NRF SARAO can implement to develop skills	49
4.4	Length of services or involvement in the project.....	51
4.5	Objective-based discussion.....	52
4.5.1	Programmes are being offered by the NRF SARAO for community development	52
4.5.2	Effectiveness of the skills development programmes currently being implemented by the NRF SARAO	53

4.5.3 Strengths and weaknesses of the programmes being offered by the NRF SARAO	54
4.5.4 Programmes the NRF SARAO should implement to develop the Karoo communities	56
4.6 Importance of skills retention and skills transfer in the Karoo	57
4.7 Summary	58
CHAPTER FIVE	59
CONCLUSION AND RECOMMENDATIONS.....	59
5.1.1 Proposition 1: The communities are aware of programmes being offered by the NRF SARAO for community development in the Karoo, South Africa.....	59
5.1.2 Proposition 2: The skills development programmes currently being implemented by the NRF SARAO in the Karoo, South Africa are highly effective..	59
5.1.3 Proposition 3: The number of strengths and weaknesses of the programmes being offered by the NRF SARAO for community development in the Karoo, South Africa, are equal	60
5.2 Recommendations.....	60
5.2.1 NRF SARAO	61
5.2.2 Karoo communities.....	61
5.2.3 Research	62
REFERENCES.....	63
APPENDICES	69

LIST OF FIGURES

Figure 2.1: Factors determining skills transfer.....	19
Figure 3.1. Location of the SKA project in the Northern Cape Province, South Africa	26
Figure 3.2: The research onion	29
Figure 4.1: Gender of the participants	38
Figure 4.2: Age group of participants	39
Figure 4.3: Qualifications of participants	40
Figure 4.4: Effectiveness of HCD programmes in fulfilling their objectives.....	46
Figure 4.5: Comparison of strength and weaknesses of the skills development programmes	47
Figure 4.6: Length of services or involvement in the project	53

LIST OF TABLES

Table 2.1: Old and new business realities in NRF and SARAO	21
Table 4.1: Gender of the participants	37
Table 4.2: Age group of the participants.....	38
Table 4.3: Qualification of the participants	39
Table 4.4: Developments that can be made to the Karoo and how to make the skills development programmes effective	41
Table 4.5: Type of skills needed by the NRF SARAO in the Karoo	42
Table 4.6: HCD programmes being implemented by the NRF SARAO in the Karoo.	42
Table 4.7: The reasons for developing and implanting skills development HCD programmes	43
Table 4.8: Main beneficiaries of HCD programmes.....	44
Table 4.9: How does the programmes work.....	45
Table 4.10: Effectiveness of HCD programmes in fulfilling their objectives.....	46
Table 4.11: Strengths of the HCD programmes currently implemented at NRF SARAO	48
Table 4.12: Weaknesses of the HCD programmes currently implemented at NRF SARAO	49
Table 4.13: Factors that have hindered the effectiveness of these programmes	50
Table 4.14: What the NRF SARAO can implement to develop skills.....	51
Table 4.15: Length of services or involvement in the project.....	52

LIST OF APPENDICES

Appendix 1: Questionnaire Interview Questions.....	70
Appendix 2: Ethics Informed Consent Form.....	73
Appendix 3: Ethical Clearance from the University	77
Appendix 4: Language editing letter.....	78

CLARIFICATION OF KEY CONCEPTS

- **Development of skills:** The process of classifying the skills gap and then consequently devising a plan to cultivate these scarce skills.
- **Shortage of skills:** The demand for a particular skills is more than the supply of that particular skills in the various labour markets.
- **Strategy:** A plan of action that is utilised in a conscious way.
- **Proficiency:** A good standard of ability and skills with a high level of expertise.

ABBREVIATIONS

BD	Brain Drain
CPUT	Cape Peninsula University of Technology
E&C	Engineering and Construction
IPR	Intellectual Property Rights
IRP	Interest Rate Parity
IT	Information Technology
NC	Northern Cape
NQF	National Qualifications Framework
NSF	National Skills Fund
OECD	Economic Output of a Country is Development
R&D	Research and Development
RSA	Republic of South Africa
SA	South Africa
SANSDS	South African National Skills Development Strategy
SETA	Sectoral Education and Training Authority
NRF	National Research Foundation
SARAO	South African Radio Astronomy Observatory
TT	Technology Transfer

CHAPTER ONE

1.1 Introduction

This study examined evidence of technology skills requirements and developed a skills strategy to address human resource or workforce needs of technology companies like the Square Kilometer Array (SKA). While there is sufficient labour to support farming activities, skill requirement to support technology projects are acutely in short supply (van der Hoef, 2017). Although it is assumed soft management skills are needed, the supply of Science, Technology, Engineering and Mathematical (STEM) skills are very low. A strategy to develop and supply such skills may not necessarily be the core function of SKA project, but they can certainly make some contribution towards the success of the project.

In South Africa, a global technology project based in the Northern Cape seeks to construct the SKA radio telescope, covering over a square kilometer in the Karoo area (van der Hoef, 2017). Upon completion of the SKA project, it will mainly consist of several thousand of radio telescopes that will be spread across a collecting area of 1 km² (SKA SA, 2016; Isaacs, 2016). Australia and South Africa co-host the main structures of the SKA telescope, with an additional of satellite dishes that will reach to other African countries (Botswana, Zambia, Mozambique, Namibia, Mauritius, Madagascar and Ghana) (SKA SA, 2016; Isaacs, 2016). Compared to the Hubble Space Telescope (a powerful radio telescope at the moment, among other telescopes in the world), the images that will come from the SKA satellites will exceed the resolution quality of the Hubble Space Telescope by 50 times. The Karoo was chosen as the site for the project because of the need for non-radio interference with signals from mobile communication, global positioning system (GPS) satellites, air traffic and Wi-Fi (SKA SA, 2016; Isaacs, 2016). The site is also one of the most quietest locations in the world, with most ground economically reliant on agribusiness specialising in sheep farming and this industry has presented countless amounts of labour in the last twenty years. The Karoo is largely immature, mainly missing workers skilled in manufacturing, artisans, mechanical, electronic, civil, and metallurgical engineering, electricians, boilermakers, fitter and turners, and fibre technicians (SKA SA,

2016; Isaacs, 2016).

1.2 Background to the study

As indicated earlier, the Karoo is currently facing a serious shortage of experienced workers in the fields of mechanical, civil, electronic and metallurgical engineering. Equally in short supply are specialists such as astronomers, data and computer scientists, information technology (IT) specialists, mathematicians and stakeholder management professionals as well as drafting technicians, boilermakers, electricians, fibre technicians, and fitters and turners, all of whom are required for the National Research | Foundation South African Radio Astronomy Observatory (NRF|SARAO) project. Shortage of skills in the region could be attributed to the low pass rates as recorded in the national matric education reports. The lack of skills negatively affects the country's economic prospects and on global participation. Poor skills transfer and retention in an organisation such as the NRF|SARAO may adversely affect socio- economic growth and development in the Karoo region.

Various programmes and Acts, including the Skills Development Act of 1990 (Section No. 98) and National Qualifications Framework (NQF) were created by the South African Qualifications Authority Act (SAQA) of 1995 (No. 58) to increase accessibility and portability of qualifications in order to assist students in improving their education and training levels. In addition to the National Qualification Framework Act of 2008 (No. 67) aimed at promoting, transferring and retaining skills in order to address skills shortages, these programmes have not achieved their goals because engineering and technology companies in South Africa have ineffective training programmes. The media highlighted this problem, resulting in criticism from social partners, including the government, employer bodies and trade unions. The literature indicates that the high unemployment rate in South Africa is associated with a lack of skills transfer and retention, which negatively affects the country's economic growth (Rasool & Botha, 2011:1). Further, the South African government insisted on affirmative action and employment equity in the late 1990s, which may have contributed to unemployment. This resulted in people with engineering and technology skills leaving the country because they felt unappreciated by

the government (Plaatjies & Mitrovic, 2014).

1.3 Problem Statement

Establishment of the SKA project in the Northern Cape Province of South Africa is relatively new, and the project is likely to suffer from potential risks and conflicts if it is not well managed. Communities in the Karoo region experience harsh living environments and poor socioeconomic conditions daily. Therefore establishment of the SKA brings hope to the communities. It is difficult for social scientists to overlook this paradox in that situation and/or ignore the various tensions this juxtaposition has created (or will create) in the Karoo region. During the SKA proposal, various promises were made to develop the local economy, develop the workforce, create jobs and improve education opportunities, especially in science. Failure to fulfill these mandates by the SKA might lead to disgruntled communities and less support for SKA projects, programmes and initiatives.

1.4 Significance of the study

Projects and communities are interdependent as projects cannot operate in a vacuum; they operate in communities where they can potentially provide employment and other values to the communities. Indeed, projects like these that are associated with various socio-economic perceptions by resident communities. It is vital to evaluate the benefits associated with the SKA project with particular reference to workforce and skills development. Understanding the communities' perceptions and expectations helps to determine whether they are benefiting from the SKA project, as it is the mandate of projects like the SKA to empower local communities through various projects and activities. This study could assist the government of South Africa to accelerate development of policies to encourage projects and organisations to participate and fully implement social responsibility initiatives in communities they operate. By unpacking and documenting problems such as those that motivated for this study, it facilitates government and organisational intervention so that the problems are holistically handled for the benefit of the employees and the community at large. The study is also important in the academic field as it describes how organisations and projects that were introduced

contribute to skills development of its employees. Lastly, this study benefits the researcher as she gets the technical skills of doing research and gets a Master's degree from the CPUT.

1.5 Aims and objectives of the study

The study had two aims. First, it sought to determine the extent to which the SKA project has contributed to workforce skills and development of communities in the Karoo region. Secondly, it aimed to understand the perceptions of local communities regarding the workforce and skills development programmes provided by the SKA project to empower local communities in the Karoo region.

Specifically the objectives of the study were:

- To determine the programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa.
- To determine the effectiveness of the skills development programme currently being implemented by the NRF|SARAO in the Karoo, South Africa, and its impacts on society.
- To investigate the strengths and weaknesses of the programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa.
- To determine the programmes the NRF|SARAO should implement to develop the Karoo communities of South Africa.

1.6 Research questions

- What programmes are being offered by the NRF|SARAO for community development in the Karoo, South Africa?
- How effective are the skills development programmes currently being implemented by the NRF|SARAO in the Karoo, South Africa, and how do they benefit society?
- What are the strengths and weaknesses of the programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa?
- What programmes should the NRF|SARAO implement to develop the Karoo communities of South Africa?

1.7 Propositions

This study was based on three propositions, stated as follows, that were tested:

Proposition 1

The communities are aware of programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa

Proposition 2

The skills development programmes currently being implemented by the NRF|SARAO in the Karoo, South Africa, are highly effective.

Proposition 3

The number of strengths and weaknesses of the programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa, are equal.

1.8 Definition of key concepts

Skills development: A procedure of identifying the skills that are lacking and ultimately coming up with a plan that cultivates the scarce skills.

Shortage of skills: This is when particular skills are in more demand than their availability in the labour market.

Strategy: A mindful action plan to address or solve a particular problem.

Proficiency: A standard of cathat results in excellent work.

1.9 Limitations of the research

This study had two limitations. The first was scarcity of recent literature sources, for example, journals and textbooks, with information on South African environment studies limits the current study. Secondly, as the study focused on the SKA project only, its findings cannot not be generalised to other projects in South Africa. However, even though the results might not be generalised to other projects, the study can still have relevance in terms of informing on the sociocultural challenges faced by communities when projects are introduced onto their doorsteps.

1.10 Delimitations of the research

The study set a boundary to define what to include for this particular study with guidance from the research topic as well as the objectives. The study looked at skills development in the Northern Cape Province of South Africa, particularly targeting workers employed by the NRF|SARAO. This then excludes other engineering projects and organisations from the Northern Cape and other provinces of South Africa. Nonetheless, information generated from this study can still have relevance to other organisations and projects in South Africa.

1.11 Outline of dissertation

Chapter One: This chapter introduced the thesis, giving the background of the study as well as the research problem, objectives and research propositions.

Chapter Two: This chapter looked at a broad review of literature relevant to the research study.

Chapter Three: This chapter presents the research process and methodology, and data analysis tools utilised in this study.

Chapter Four: This chapter presents the results from this study and discusses them in line with the research objectives.

Chapter Five: This chapter provides the conclusions for the current study and recommendations for future studies.

1.12 Chapter summary

Chapter one introduced the research topic as well as the background, and identified the SKA's research problem, which is associated with socioeconomic impacts on the Karoo communities. Research objectives, questions and propositions are also presented in line with this study. The following chapter provides a literature review to provide the theoretical background for this research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The previous chapter introduced the research topic as well as the background, and identified the SKA's research problem, which is associated with socioeconomic impacts on the Karoo communities. This chapter describes in detail, information about the SKA project. It also highlights some findings of other researchers who studied projects established in various regions, how the projects established relationships with resident communities and how the findings may be integrated and implemented in this study.

2.2 The SKA project

After a lengthy bidding process between Australia and RSA, it was decided on the 25th of May 2012 that both countries would share the SKA project. However, RSA was allowed to host the larger share. Before the bid, RSA managed to complete a prototype comprising of 7 dishes, namely the KAT-7 (December 2010) that is, in the identified SKA site (SKA SA, 2016; Isaacs, 2016). Construction Phase 1 of the SKA in RSA was proposed to be between 2018-2023, which was aimed to build additional 133 satellite dishes in the Great Karoo. At the end of phase 1, the project aims to have completed about 197 dishes in an array spread over a baseline of up to 150 km. Phase 2 of the SKA project is scheduled to take place between 2023 and 2030, and will include the extension of the baseline to approximately 3000 km, as well as the construction of outstations in the other African partner countries (SKA SA, 2016).

To build such a massive project, the NRF needed to acquire an areas of land in the designated area. Initially, two farms (Losberg and Meyersdam) with a surface area of 13 406 ha were bought. These farms have been used in developing the KAT-7, with 64 satellite dishes of the MeerKAT, which is currently being constructed. In 2016, the SKA made it publicly indicated that it planned to buy 36 farms in the designated core area to extend the SKA land to 118 000 ha (Wild, 2016). Some farmers have been challenging

the process of being bought out by the NRF|SARAO. However, the chances of success are slim; if the negotiations fail, the government of RSA has the right and authority to acquire their land by law (SKA-SA, 2015). The land acquisition will most likely upset the affected individuals and communities who will negatively perceive the SKA project.

The SKA project aims to understand the evolution of the universe and the processes of galaxy and star formation. It is believed that the SKA project enables scientists to discover information that we cannot currently imagine and maybe even discover life elsewhere beyond what we can imagine (SKA-SA, 2016). This project requires the development of one of the most advanced technologies that includes designing the fastest supercomputers in the world to process the huge data which the telescope produces. The SKA project will consist of approximately, thousands of radio antennas that are able to sense and detect even the weakest radio signals from the outer space thereby enabling astronomers to be able to analyse the universe in such an exceptional detail (SKA-SA, 2016).

The antennas are highly sensitive, and the developers of the SKA project stressed that it was importance for the telescopes to be located in an area with a low population and as far away as possible from any other machines and electronics that could interfere with the radio waves coming from the universe. The other consideration was that of the core sites required to be built on a dry, elevated area in order to prevent waves from being absorbed by the atmospheric moisture. The Great Karoo area was chosen as the ideal area for the SKA project specifically between the towns of Vanwyksvlei, Brandvlei, Carnarvon and Williston. In 2014, the government of South African declared the area around the core site of the SKA, a 'Central Astronomy Advantage Area' according to the Astronomy Geographic Advantage Act of 2007 (No. 21) (Department of Science and Technology, 2014).

2.3 The SKA project and local community development

The NRF|SARAO has managed to initiate several local development projects and programmes in the Karoo since the KAT-7 completion in 2010 end. Although the primary

aim and goal of the SKA project is to establish the world's most advanced radio telescope, one of the decisions that was made by the South African government was to ensure that local communities are improved through the SKA project (Binneman & Davies, 2021). The socioeconomic situation in the Northern Cape Province made the need for development projects evident for local communities. National statistics on education, poverty levels and unemployment rates all warranted the need for various developmental initiatives concentrating on education, and information and communication technology access. The SKA project proposal promised Northern Cape communities that the project would bring job creation, aid the local economic development and improve opportunities for the youth through science and education promotion (Wild, 2016). These sentiments were also emphasised by the SKA management (van der Hoef, 2017).

On the SKA SA's official website (2017), the SKA claims that they have created over 1 000 jobs through infrastructure upgrades and construction on and around the SKA SA site and ensured that a minimum of 14% of the overall contract value of SKA construction projects 'should include participation from local contractors' (SKA, 2016). The SKA also claims it has boosted the local economy through a salary injection of R 9.46 million in 2015 and R 8.45 million in 2016, as well as through expenditure at local suppliers (Atkinson et al, 2017). According to Atkinson et al (2017), a total of R 15.2 million was spent in 2015 and R 52.3 million in 2016. Since 2011, the SKA SA has also awarded 40 bursaries to deserving students from Carnarvon and surrounding towns to enrol at the high school in Carnarvon as part of their Human Capital Development Programme. At the end of 2016, four matriculants from Carnarvon received bursaries to further their studies in the fields of computer science and physics at tertiary institutions (SKA SA, 2017). In cooperation with the NGO Teach SA, the SKA SA has also provided the high school with a mathematics and science teacher and, in partnership with another NGO, has opened a computer centre in Carnarvon where people can learn how to use computers and the internet (SKA SA, 2017). Owing to all these documented positive impacts by the SKA project, it is vital to determine the perceptions of the recipients of these opportunities in terms of inclusivity as well as the overall benefit of the programs offered by the responsible organisations which is the gap that is being filled by this study.

2.4 Other global projects

Across the globe, several socioeconomic, political and environmental dimensions have been shaping communities' functionality, fortunes as well as relevance at the basic level of human society (Mensah & Okyere, 2014). Development project inception is usually marked by political grandstanding with an emphasis placed on the need for trade-offs between meeting socioeconomic developmental targets and debt servicing rather than on welfare of affected communities. Globally, various projects have been introduced onto the doorsteps of various communities, just like the SKA. Similarly, these have received various reactions from the resident communities, and for them to establish well, they have to carry various benefits to give back to the resident communities. Problems involved in the interrelations of projects and communities have been explored by many researchers (Mensah & Okyere, 2014).

Large development projects such as construction, roads, exploitation/extraction and dams have displaced, at least, 300 million people globally between 1988 and 2008 (Terminski, 2012). Construction of the Kariba Dam from 1953 to 1958 displaced more than 50 000 people of the Tonga tribe in Zimbabwe and Zambia from the submergence zones (Mashingaidze, 2013). The construction of three large Gorges Dam in China affected a significant population from the area of the construction site. In India, 2.55 million people were affected by mining development between 1950 and 1990 (Terminski, 2012) and in Zimbabwe, thousands were affected by the establishment of diamond mines in the Eastern Highlands. In Ghana, mining companies relying on extensive land have faced challenges coexisting with the indigenous communities whose livelihoods have intrinsically been connected to their land (Mensah & Okyere, 2014). Conflicts have often been reported between the mining companies and local communities, with the mining companies being accused of fuelling the conflicts through their mining operations. The conflicts usually are associated with livelihood security, the access to resources, user ownership, detrimental effects on environment, cultural beliefs, and the violation of human rights (Mensah & Okyere, 2014).

The few examples discussed in the preceding paragraph imply that developmental programmes often affect the livelihoods of resident communities, for which reason the responsible organisations should ensure that the process of acquiring the land transitions smoothly without any aftermath conflicts. The responsible organisations should ensure that their projects empower communities through various programmes, which is one of the objectives of this study: skills and workforce development programmes provided availed by the SKA and how communities of the Karoo benefit from these programmes. The SKA contributes to scarce skills not only in the Northern Cape Province, but in the entire country as a lack of genuine skills is generally affecting productivity of labour and hampering the ability to innovate as well as to adopt new technological developments (Brunello & Wruuck, 2021:1145).

Shortage of highly skilled labour is a global phenomenon and many countries are continuously concerned by the shortages of skilled labour and professionals in various vital sectors (Mateus et al., 2014:63; Akinradewo et al., 2022). For individuals, not having the rightful skills limits employability prospects and their access to quality jobs (Brunello & Wruuck, 2021:1145). While there is sufficient labour to support manual jobs such as farming activities, skills required to support technology projects are in short supply. It can be assumed that soft management skills may be needed, but the supply of Science, Technology, Engineering and Mathematical (STEM) skills are in short supply. A strategy to develop and supply such skills may not necessarily be the core function of the SKA, but it can certainly contribute to the project's success. Technological change is a significant factor that induces sectoral dynamics: with some sectors gaining employment and others shrinking; and changing of the demand for skills within firms and occupations (Brunello & Wruuck, 2021:1147).

2.5 Skills shortage in South Africa

Plaatjies & Mitrovic (2014) explain that South Africa (RSA) experiences skills shortage across different sectors, particularly in the engineering and technology companies. These shortages of skills in the engineering and technology sectors are widely documented (Business Tech, 2022). Nevertheless, the RSA still invests infrastructure of technology

and engineering, specifically in the new power-generation projects that provide economic and employment opportunities that must be seized to ensure the country's future capability (Mncayi & Meyer, 2022). The acute shortage of skills faced by the engineering, construction and technology sectors remains a severe constraint for South Africa, despite the number of public and private resources dedicated to addressing the problem which is growing (Akinradewo et al., 2022).

According to Mncayi and Meyer (2022), the skills scarcity problem is intensified by shortage of experienced instructors, given South Africa's high national unemployment level. Plaatjies and Mitrovic (2014) states that South Africa's low skills levels limit the hiring of local people and that this can be solved by developing the required skills amongst local people. Plaatjies and Mitrovic (2014) sees the critical challenge as remaining committed to generating wealth and skills, while managing local expectations. The skills supply pipe line for construction and engineering professional have been beleaguered with many challenges which have negatively affected efficiency and quality of construction projects (Tshele & Agumba, 2014). The dwindling in the skills supply pipeline is due to the fact that, to be considered for enrolment in construction and engineering programmes at institutes of higher learning, learners require higher grades mathematics and science whose pass grades are also on the downward spiral. As such, the main challenge is on restoring a skills supply pipeline that is capable of producing a kind of skills required by the construction and engineering sectors (Takawira, 2019).

To exacerbate on the issue of maths and science grades in 2004, only 3% of the matriculates could enrol for construction and engineering at DHET (Takawira, 2019). Such low figures affect the pipeline supply for skills much needed in the construction industry. One of the barriers to 26 the implementation of CA in SA is institutional, the quality of science and mathematics grades at basic education level means that few matriculates are enrolling for construction and engineering at tertiary institutions. The field of automation requires higher grades in these two subjects for the development and proper implementation of construction robotics (Takawira, 2019). In 2010 SA, ranked was placed on the 17th position of the G20 countries on the average literacy of students in

Mathematics and Science subjects. The poor quality of the education system in South African is further reflected by the country's general performance in the in the quality of Maths and Science education. In a separate survey carried out by WEF in 2016, SA ranked last on the 139 countries that were surveyed on quality of Maths and Science education. This performance is as a result of the overall poor quality of education system which seems not to be improving. This poor performance in STEM coupled by the poor quality of the education system has adversely affected the skills supply in the engineering field and the construction industry was not spared.

The causes of skills shortages in South Africa were summarised by Takawira (2019) as below:

- *Gaps in the training system*

The country's education training system is not preparing the matriculates for skills training until after leaving high school. Although the level of education and training has shown some signs of improvement in the last decade, the pace of this improvement is not consummate with the level of investment in education and training by both the government and the private sector.

- *Building the right skills*

Apart from TVET colleges, there is a lack of formal training and the right skills training with necessary accreditation. There is a lack of industry knowledge or linkage in terms of awareness about the right skills that are required.

- *Revolving door internships and learner-ships*

Although there is a number of internship and skills training programmes in the workplace by the government and other large organisations, employment is not always the outcome. In the workplace, companies take in interns in order to fulfil certain requirements. The interns complete skills training but in many cases they are not permanently employed by the same company, either due to unavailability of permanent jobs or for cost reasons. After a year or less, these interns find themselves without a job with the reality being that over time, learnt skills are lost if not kept in practise. The same companies however might take in new interns and go through the same process.

- Capacity building
Small Medium Enterprises (SMEs) which are a major growth segment for SA, envisaged to be a key employer going forward) often do not have the capacity.

2.6 Skill development strategy requirement - future/desired

In order to address the skills supply pipeline, the current education curriculum would need to be adjusted to ensure that graduates that are produced meet the world standards in terms of their performance (Takawira, 2019). Records from Department of Labour show that, very few students enrol for training in qualifications that will help in addressing shortage of skills in the country (DoL, 2016). Shortages of skilled labour which have been a hot potato issue in the country and beyond for some time now is being further compounded by the ever increasing demand for technical and digital skills due to technology evolving in the work place. The resistance by the engineering industry when it comes to change is likely the root cause of slow adoption of technology (Windapo, 2016), but regardless of this fundamental nature, institution of higher learning should be responsible to lead and drive the much needed change and improve the face of the construction industry through the adoption of technology (Holt et al., 2015). To achieve this goal, there is need to expose learners studying towards construction related programmes to emerging technologies so that as the future advances and geared for Revolution 4.0, already there is a skills base capable of implementing such technologies in the construction industry. Engineering and technology firms contribute money to the skills levy that is reclaimed for implementing of appropriate engineering-related training courses (Palmer, 2020). Within South Africa, there is a strong sense that all engineering and technology companies are facing the challenges of severe skills shortages in the fields earlier highlighted in this study.

2.7 Retention of experience personnel

With growing exodus of people with skills from the country, there is a need to ensure retention is built into the skills development strategy. Retention incentives must form part of the strategy to attract and retain skills without which the technology and engineering sector may be adversely affected. As earlier indicated, factors influencing emigration

include poor educational standards. High crime rate is costing the country a significant loss of revenue and human lives (Plaatjies & Mitrovic, 2014), thereby reducing its capacity to achieve matching levels of technological progress as experienced in other economies. The authors further argue that a lack of interventions that address the challenges confronting skills shortages continue to burden the country. Subsequent monetary growth was a little difficult to find because of excessive emigration of experienced personnel resulting from South Africa's democratic government's seemingly draconian regulations.

2.8 National qualifications framework

Even though the National Qualifications Framework of 2008 (No. 67) seeks to encourage skills development by introducing relevant primary and higher education curriculums, the RSA still encounters significant skills shortages due to the lack of adequate skills transfer and retention even though the RSA Qualifications Authority Act of 1995 (No.58) formed a frame work for national qualifications to raise access to portability for learners to improve their qualifications. Plaatjies and Mitrovic (2014) states that the lack of skills transfer and retention is a significant challenge to providing job solutions and financial development in South Africa. As mentioned earlier, during the late 1990s, factors such as emigration, employment equity and affirmative action substantially increased role towards increasing unemployment. Plaatjies and Mitrovic (2014) explain the required skills and talents necessary to improve in technology and engineering companies.

2.8.1 Importance of skills transfer in engineering and technology

Regarding the importance of skills transfer by SARAO in South Africa, Brewster et al. (2016:210) explain that in technology and engineering companies, skills transfer and retention is a reality and despite SARAO's great job offerings, vacancies still remain because of limited benefits and poor working conditions. Technology transfer professionals often ignore the wide range of important skills needed in the technology and engineering. However, some of these skills may be more have more influence compared to others, but skills development has primarily all technology and engineering transfer professionals as being similar (Volberda et al., 2012). Technology should be applied in the methods professionals employ to ensure skills transfer and retention

(Volberda et al., 2012). Several related factors that affect technology and engineering skills transfer professionals focus on the fact that these instructors are mainly involved in some activities that are related to technology commercialisation by permitting sharing of knowledge, that is, when the experts usually possess an extensive diversity of accomplishments (Plaatjies & Mitrovic, 2014). Current collaborative knowledge suggests technology transfer professionals' activities are related to 'spin-offs' from new business development.

2.9 Impact of skills development programme at NRF|SARAO – present

South Africa managed to establish a Human Capital Development programme (HCD) in 2005, to create capacity in the relevant radio astronomy (Rivkin, 2018). This programme, is available for South Africans, students from the NRF|SARAO, African partner countries and provides support at all the academic levels to ensure that a continuous throughput of young personnel move to relevant studies and skills development programmes to ensure that the required supervisory as well as teaching capacity are in place for students support (Rivkin, 2018). SKA SA sponsors five matric learners' bursaries to study science and engineering-related fields from 2016. The learners achieved matric exemptions in maths and science, a first for Carnarvon High School.

The support by the NRF|SARAO is well described on the NRF|SARAO website. NRF|SARAO has awarded more than 40 student bursaries since 2011. More than 116 Masters students and 52 PhD students as well as funded six research chairs at South African universities have been supported by the NRF|SARAO. Bursaries have supported the training of seven young people, who are now completing their training at the Losberg site, 90 km outside Carnarvon and will start work in industry once their training is completed. They will work as electricians, fitters and turners; and in instrumentation and control. NRF|SARAO has employed four local young people from Carnarvon as interns after they have received training in optical fibre technology. To date, NRF|SARAO has spent more than R 2.5 million on laptops, training and connectivity, with 366 new computers with state-of-the-art software being donated to schools and the library in Carnarvon (Smith, 2019).

2.10 Imperative of skills transfer and retention in the Karoo

Specific technological knowledge and expertise are as necessary as the hard skills for the technology and engineering transfer professionals (Volberda et al., 2012). A study by Wild (2016) highlights the significance of soft corporate skills by stressing the importance of corporate indulgent services, but not undermining the need for technology transfer professionals in the Karoo to possess expertise in both Interest Rate Parity (IRP) as well as legal skills. Thus, it is deemed imperative that the technology transfer units and offices do ensure that their practitioners have an access to such skills. It has however been identified that the technology transfer professionals are not even concerned about the possession of such skills. Siegel (2003) and Arenas & González (2018) explain that technology transfer also requires negotiation skills and defining negotiation. Interactions through which others are perceived to satisfy various interests, collective advantages or craft outcomes agree upon a source or action and bargain for either an individual or collective outcome.

It has been stressed, however, that negotiation skills differ from other sources of knowledge and, thus, are often difficult to develop and practice (Siegel et al., 2003; Arenas & González; 2018).

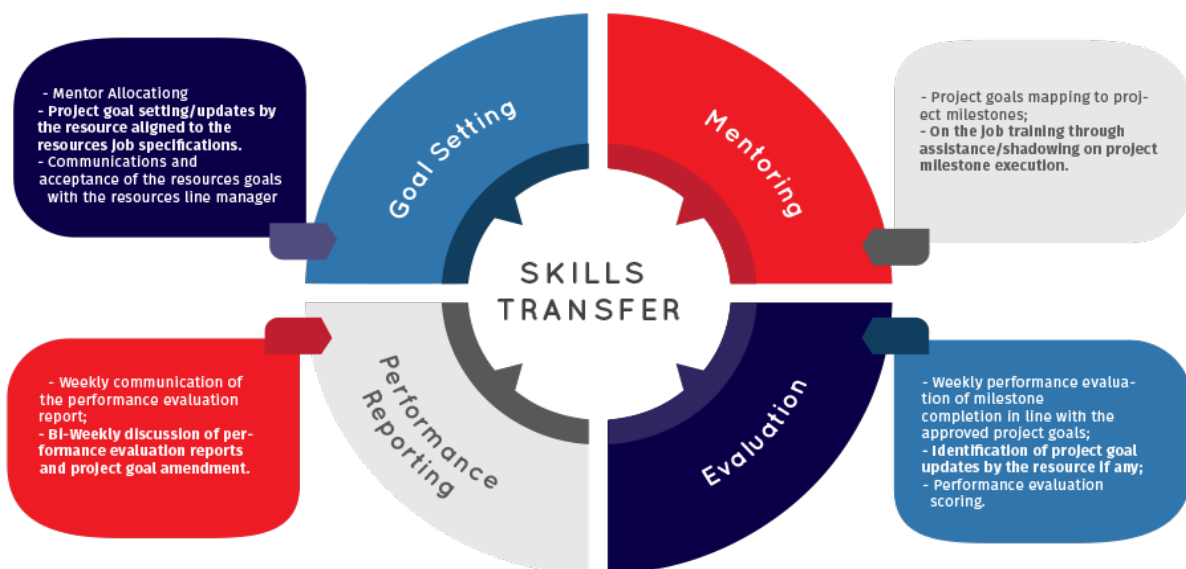


Figure 2.1: Factors determining skills transfer. Source: Siegel et al. (2003)

2.11 Career planning and professional growth

The exciting career planning path is essential in the Karoo, as it provides employees, professional growth and a sense of company values. Craig (2015) advocates that companies establish suitable skills retention and transfer strategies and ensure these processes are closely monitored. Retention efforts should focus on a company's top performers because this practice is key to successful retention. Many employees who believe that their personal goals conflict with those the company has planned for them expend minimal effort in their jobs and often leave their posts after a few months (Craig, 2015). A company's competitors often pursue their best employees because they know they are both knowledgeable and well trained in their current work environment. Thus, it is important companies guard against the possibility of losing valued personnel in this way.

2.12 Employee turnover in engineering and technology firms

The financial costs associated with replacement and transition, loss of production, reduced performance levels, overtime, reduced competitive advantage and low morale are often high after an experienced employee leaves. Brunello and Wruuck (2021) indicate that employee turnover costs engineering and technology firms approximately 140-160% of the workers' yearly income. Employee turnover in engineering and technology companies relates to workers' voluntary and instinctive association of workers within engineering and technology companies (Brunello & Wruuck, 2021). In these companies, employee turnover often is the company's loss of employees as a percentage (%) of the staff within a defined period. Two types of turnovers include voluntary and involuntary turnovers. Voluntary turnover results from an employee's personal decision to resign and seeking an alternative job, while involuntary turnover results from the company's decision to relieve an employee of his/her duties due to uncontrollable issues e.g. poor health, death or old age - retirement (Pietersen & Oni, 2014). Employee turnover is a dysfunctional practice for engineering and technology companies in the Karoo, while voluntary turnover is common and more prevalent than involuntary (Berry et al., 2012).

2.13 Working conditions

Most employees leave because of poor quality working conditions in the Karoo, inadequate compensation, gender differences and inability to advance their careers owing to a lack of promotion prospects. These factors explain why an employee in the Karoo is unproductive and often late for work and offer three motivational factors employers can unilaterally apply to the workforce that might reduce companies' unproductive staff turnover. A study by Ganster & Rosen (2013) explain highlights that most employees leave because of poor quality working conditions, inadequate compensation, gender differences and inability to advance their careers owing to a lack of promotion prospects. These authors (2013) explain that employees who work straightforward and repetitive jobs often feel disgruntled and leave the company. Many employees of technology and engineering companies' employees feel they are overworked, their inputs are not sought and their contribution appreciated, all of which could be resolved, but are usually ignored by management (Ganster & Rosen, 2013).

Table 2.1: Old and new business realities in NRF and SARAO

The old reality	The new reality
Negative perceptions on women were not considered to be good qualified scientists, technologists and engineers.	Development in most technology and engineering companies has grown with women comprising 41% of highly qualified scientists, technologists and engineers.
Software in construction companies are rarely utilised and that construction companies continued to use the manual methods.	There has been an increase in the provision of construction-focused hardware and advanced software programmes with analytical capabilities.

Source: Ganster and Rosen (2013)

2.14 Effectiveness of skills development programmes by NRF|SARAO

NRF|SARAO could facilitate business opportunities, science, employment and innovation potential thereby putting Africa, specifically South Africa, on the limelight. The multi-billion rand NRF|SARAO, being hosted jointly in South Africa and Australia, was extended into 8 African countries and will host the largest telescopes in the world.

The SKA project will also be one of the biggest multifunctional scientific projects and collaborations in the name of science (Wild, 2016). With several thousand of linked radio-wave receptors in the two countries, the NRF|SARAO radio telescope will be constantly scanning space and feeding the data to the astronomers worldwide. The project will collect and transmit huge data which will require supercomputing power as well as ‘Big Data’ management and analytical capabilities on an unprecedented scale (Washington, 2018; Wells, 2019). The NRF|SARAO project works with the world’s most crucial Information and Communications Technology (ICT) powerhouses on this joint venture in Colombia (Wang et al., 2021). One aspect of NRF|SARAO was seeing the Netherlands Institute for Radio Astronomy (NIRA) as well as the IBM collaborating in order to provide high-speed but low power exascale computers for data transport as well as storage

processes (Bvuma & Marnewick, 2020). These streaming analytics were required to read, store and analyse all the raw data collected daily.

Space science supports the creation of an environment that is conducive for the implementation of the South African National Space Agency (SANSA). The South African Earth Observation (SAEON) strategies jointly addresses developing innovative applications as well as human capital in order to respond to the national priorities. Through the SANSA, South Africa's capacity to design, build, maintain, and even launch satellites into space, is being developed. South Africa has already begun work on the ZA-ARMC1 satellite, thereby enhancing the continent's ability to manage its natural resources. The second tranche of the purchase price for Sunspace (a satellite company), brought to an end the struggling company's ordeal owing to its inability to pay the creditors (Bvuma & Marnewick, 2020).

2.14.1 Capacity to aspects of programme development

The NRF|SARAO has focused on the development of skills relevant for operations as well as maintenance services of the MeerKAT facility. Technician and Artisan courses and training programmes have well-defined outlines and schedules of technically experienced staff numbers required and are able to meet the capacity needs. In the Karoo towns the NRF|SARAO have facilitated the recruitment of maths and science teachers in schools, provided bursaries for potential learners to attend schools, rolled out cyber labs and e-learning centres (in cooperation with the Departments of Education and Rural Development, and with industry partners), and trained residents that manage cyber-centres available to members of the community. NRF|SARAO pioneers the ability to reduce such data to a manageable size through the real-time interconnected network and intelligently high voluminous data.

2.14.2 Market opportunities for NRF/SARAO

A study by Wall and Welsch (2013) suggests that commercial items or the production of new products may have an excellent potential for adjacent market opportunities for NRF|SARAO in ICT, whereby software and hardware commercial items' packages may

either be adapted or new products developed. Many of these products would also be helpful to other geographically distributed sensor networks, with only some of these innovative designs being partly specific to NRF|SARAO (Smith, 2019). Rivkin (2018) states that the direct and indirect benefits of NRF|SARAO to society, in general, are via training and development for technicians. NRF|SARAO infrastructure is comparable with the financial and commercial sector's ICT infrastructure. NRF|SARAO is breaking new grounds in engineering and construction. This high standard is influenced by international standards for software and hardware and provides the environment applications with an ability to detect as well as analyse natural events in real-time (Rivkin, 2018). These applications require smart development models and worldwide communication when microelectronics and protocols handle colossal data traffic.

2.15 Digital converters and wireless communication

Analogue to digital converters (ADCs) and low-noise amplifiers (LNAs) provide wireless communication through the development of extremely low-noise drive innovation at NRF|SARAO (Smith, 2018). NRF|SARAO drives innovation in software and algorithms for data manipulation, compression, selected data flagging of transients and some other notable signals, as well as enhanced processing of the selected segments. These are crucial devices in electronics and communication technologies in virtually all digital processes and a giant network is the sensor network and signal processor.

2.15.1 *Developments that were used for ICT*

Developments used for ICT are in four main areas:

- Surveillance intelligence for recognising faces in the crowd and license plates.
- Retailers and markets that are able to intelligently adjust the financial conditions in the world.
- Interconnected area military application and security must both sense and respond to the rapidly changing conditions in a vast area.
- Traffic monitoring and weather response activation followed by anomalies

2.15.2 *What constitutes design and development?*

Design and development constitute the process of establishing what information is needed on how to manufacture a product in order to ensure it can be easily distributed, sold and serviced. Therefore, it is defined as a simultaneous design process. McEwan et al. (2017) explain that only narrow product reducibility issues fall within the scope of educational programmes that can vary widely.

2.16 Summary

This chapter presented a detailed review of existing literature on how projects introduced at the doorsteps of local communities often lead to conflicts if community needs are not well catered for. The conflicts are due to the fact that communities are custodians of the land (besides the state powers) and have the right to benefits and programmes associated with the particular project. A skills transfer and skills retention framework was suggested, which paved the way for such a strategy and guided data collection and data analysis of this study's proposed skills development. The chapter also described the SKA project and how it came about. The next chapter focuses on the design and methodological aspects of the study.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapter presented a detailed review of existing literature on how projects introduced to the doorsteps of local communities often lead to conflicts if community needs are not well catered for. This chapter gives a clear and detailed description of how the study was conducted to answer the skills development questions posed. The chapter highlights sampling issues, methods of data collection, skills development instruments and ethical considerations, concluding with a summary relating to material covered and explored in the next chapter.

3.2 Study area

The study was conducted in the Karoo area, Northern Cape Province of South Africa (Fig. 3.1). The Northern Cape is the country's largest province in South Africa and is the most sparsely populated province, with only about 2.3% of the population living in small towns. A great deal of this province lies in the dry Nama Karoo Biome, which is home to a several diverse plants such as the elephant's trunk tree and various succulents. Its spectacular array of florals in the spring season attracts thousands of tourists each year to the province.



Figure 3.1. Location of the SKA project in the Northern Cape Province, South Africa

3.3 Framework proposal sustainability

The literature review and Framework Proposal Sustainability (1889:9) explains that developing tooling and processing equipment shared among various functions and development activities are often completed before control and responsibility process designers finalise the product specifications. McEwan et al. (2017) state that these design concepts are integrated into the manufacturing process in a similar way so that any concerns may then be addressed by allowing manufacturing personnel to be able to influence design of the product in ways that ensure that it is less costly or easy to produce.

3.4 Skills development philosophy

Skills development philosophy refers to "...the world view within which skills development

is situated” (Quinlan et al., 2015:55). The skills developer adopts this model to solve the skills development problem. It calls for the skills development project to “fit” the steps, purpose as well as focus of the skills development project’s philosophical processes and, enables the skills developer to choose appropriate skills development methodologies for the study. After studying both positivism and interpretivism skills development philosophies, it was decided to adopt and apply only one philosophy, the interpretivism skills development philosophy, which resulted in using a questionnaire skills development approach. The rationale for adopting the interpretivism skills development philosophy was the belief that the anticipated benefits from questionnaire skills development methods were considered the most appropriate for this skills development study. A questionnaire skills development investigates the skills development problem in its natural setting or process and attempts to make some sense of and interpret phenomena based on their meaning (Creswell, 2018). A questionnaire study also helps the skills developer understand the context within which study participants address the problem under investigation (Creswell, 2018). In short, this approach was chosen because the skills developer planned to gain deep insight into the skills development problem through an investigation conducted within the participants’ natural environment. A study by Mugobo & Wakeham (2014) explains that a skills developer’s philosophical orientation depends on the choice of skills development approach (interpretivism against positivism).

3.4.1 Research paradigm and philosophy positivism

As defined by Creswell (2018), research paradigm, methods and methodologies is a comprehensive mechanism for an interlinked practice. The intellectual portrays complexity in three facets, namely: epistemology, ontology and methodology. Methodology is refers to an investigation comprising a research design, methods and procedures. This research used a quantitative method on a company mixed study. Quantitative data collection method involves statistical data, which are interpreted to establish the connection between a theory or theories. The approach also allows for researcher examination of the relationship between two variables.

3.5 Skills development methodology

Skills development methodology describes how the proposed skills development were conducted to address the skills development problem (Wetchasit, Sirisuthi & Agsornsua, 2020). Three approaches are recognised for conducting skills development, namely: quantitative, questionnaire and a mixed method approach (triangulation) (Schoonenboom & Johnson, 2017). However, it is advised that skills developers choose the appropriate approach for a particular problem. Consequently, the three skills development approaches were scrutinised before selecting the most applicable to the magnitude and scale of this particular study.

3.5.1 Questionnaire skills development approach

Unlike quantitative skills development approaches, questionnaire skills development are based on data that cannot be directly expressed as numerical values (Cresswell, 2018). Statistical techniques are thus not viable in most mixes. Questionnaire skills development involves collecting data in words and is aimed at rather gaining an in-depth understanding of an investigation or research (Kabir, 2017) and, thus, the skills developer's rationale for using this approach. Skills developers use questionnaire skills development methodology as follows:

- Questionnaire skills development enables the skills development to gain a better understanding of a topic as it allows for a detailed view to emerge
- It facilitates a personal data experience which has a direct relationship with the skills development participants' subjective experiences and, hence, is exploratory in its application.

3.6 Skills development design

Skills development design provides details on how skills development was conducted (Sekaran & Bougie, 2013:95)

A blueprint covers a wide range of skills development aspects in terms of how data is collected, measurements and data analysis based on the skills development questions being investigated.

Below is an overview of the skills development design applied:

When presenting an overview of the selected skills development design, Johannesson (2012) recommend using the “skills development onion” consisting of the following six layers.

- | | |
|--|---|
| 1. Skills development Paradigm: | <i>Interpretivist paradigm</i> |
| 2. Skills development Approach: | <i>Exploratory (questionnaire method)</i> |
| 3. Skills development Approach: | <i>NRF SARAO were used as a Mixed Study</i> |
| 4. Horizon Time: | <i>Cross-sectional study</i> |
| 5. Methods for data collection: | <i>Interviews</i> |
| 6. Data Analysis: | <i>Questionnaire content analysis for questionnaire data.</i> |

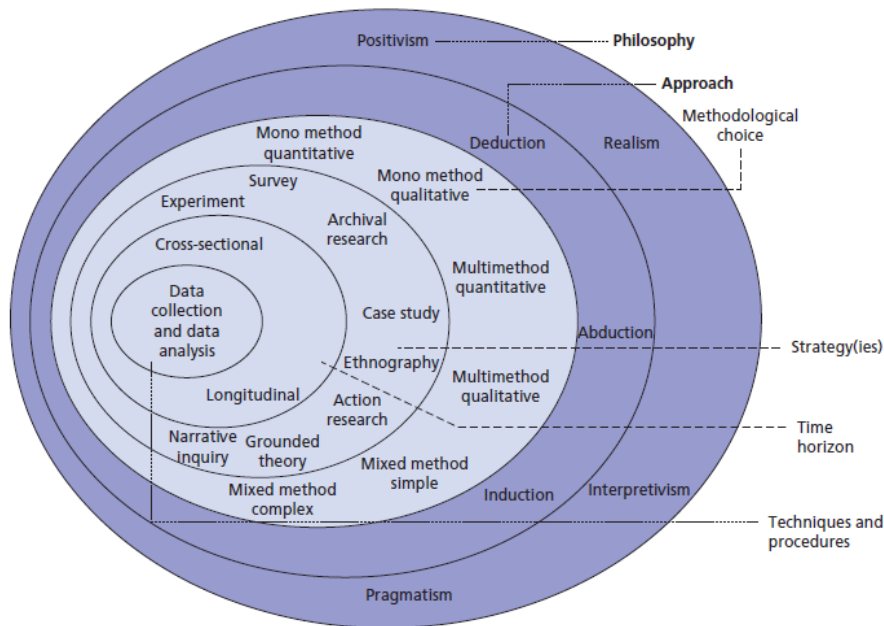


Figure 3.2: The research onion. Source: Saunders et al. (2009:83)

3.6.1 Skills transfer and retention in engineering and technology

The mixed study of Bell and Bryman (2011:110) states that a mixed study as an empirical inquiry that investigates a contemporary phenomenon within a real-life context. Mixed studies refer to a detailed investigation of particular units which may be an entity, an event or an analysis of an individual. Using a mixed study enables the skills developer to study the phenomenon comprehensively. Skills developers use numerous sources of evidence because the boundaries between the problem and context are not always clearly evident. The main components to be considered when developing a mixed study skills development include the proposition and *a priori* (if any), logical linking of the data to the proposition and interpreting the skills development findings' criteria, skills development questions and unit of analysis (Bell & Bryman, 2011:110).

In this skills development study, the skills development mixed study on transfer and retention at selected NRF|SARAO in the Karoo (Northern Cape). The practices of the talents transfer and skills retention staff at NRF|SARAO, specifically relating to the acquisition and retention of electrical and mechanical engineering staff, were examined by employing interviewing as the data collection method.

3.6.2 A mixed study for skills development study

- **Background of mixed study selected:** Studies by Rasool and Botha (2011) state that South Africa's technology and engineering industry has conducted different studies to understand better the origin of skills challenges in the technology sector.
- **Depth:** Rule and John (2011) explain that using a mixed study allows multiple uses of skills development approaches that aim to examine a particular mixed in great depth.
- **Ease of data access:** The skills developer resides in Cape Town, and although it is easy for her to travel to the Karoo, it is less cost-effective than traveling in Cape Town daily, and the possibility is "strong" that the skills developer did not reach the participant's chosen interview venue.
- **Manageability:** In line with Rule and John's (2011:8) recommendations, the skills developer chose a single mixed study as opposed to a larger scale investigation,

in order to manage it efficiently, given the fact that her time and resources were constrained.

- **Minimising skills development costs:** Due to limited financial resources, the skills developer chose to conduct skills development in Carnarvon, a small town in the Karoo, where NRF|SARAO is situated. This choice minimised traveling and other general costs because the skills developer can walk to the participants' chosen interview venues in Carnarvon. The skills development activities were bound to the skills developer's personal development budget.
- **Procedures for the mixed study:** The skills developer conducted interviews relating to the skills transfer as well as retention policy implemented at NRF|SARAO and the programmes that are being run by the HCD department and how students are engaged to become part of this programme. The skills developer determined *a priori* as coding structures to direct data collection according to knowledge from reviewed literature. The skills developer left space in the additional mixed categories to be presented in this study.

3.6.3 Methods for data collection

Data gathering refers to the collection of primary data garnered firsthand, while subordinate data refers to information previously compiled by a party other than the skills developer, thus, already available (Cresswell, 2018). Data is divided in this manner depending upon its intrinsic properties. Kabir (2017) further describes data as "...facts collected throughout the course of the skills development and these are usually expressed in the language of measurement". This skills development study, as mentioned earlier, used a triangulation skills development method, and the skills developer used several skills development methods to collect primary data in order to fulfil the study objectives. This approach allowed for significant findings to be collaborated by integrating data from each method, thus enhancing the study's validity.

3.6.4 Primary data collection: Interviews

An interview aims to explore and understand the skills development topic from a

respondent's perspective (Cresswell, 2018). As argued by Alston and Griffiths (2015) questionnaire skills development methodology is one of the most popular data collection methods. According to Alshenqeeti (2014), an interview is a means of collecting a large amount of data that cannot be easily accessed through other skills development instruments such as questionnaires and observation. Interviews involve direct individual face-to-face interaction through which a set of questions relating to the skills development problem are asked or discussed with the study participants (Alshenqeeti, 2014).

Every interview involves face-to-face interaction with the selected participants using an interview guideline containing questions (see Appendix 1). In this skills development, study data was collected employing individual semi-structured interviews. As previously mentioned, an interview guideline containing questions based upon findings recorded in the reviewed literature was used. Alshenqeeti (2014) recommends developing interview guidelines because respondents may deviate from the sequence of the interview questions.

3.6.5 Interpretation and questionnaire data analysis

Content analysis is the searching of phrases and themes similar to those raised by the reviewed literature in relation to skills transfer (as explained in Chapter 2). Phrases and themes from the literature review used to identify phrases and themes repeatedly arising in the data collected during the interviews. The following are the general steps of content analysis described in Columbia Public Health (2022), adopted for this study:

- Determine the type of analysis: Once the sample has been selected, the researcher needs to determine what types of relationships to examine and the level of analysis: word, word sense, phrase, sentence, themes.
- Reduce the text to categories and code for words or patterns. A researcher can code for existence of meanings or words.
- Explore the relationship between concepts: once the words are coded, the text can be analysed for the following:
 - Strength of relationship: degree to which two or more concepts are related.
 - Sign of relationship: are concepts positively or negatively related to each other?

Direction of relationship: the types of relationship that categories exhibit. For example, “X implies Y” or “X occurs before Y” or “if X then Y” or if X is the primary motivator of Y.

- Code the relationships: a difference between conceptual and relational analysis is that the statements or relationships between concepts are coded.
- Perform statistical analyses: explore differences or look for relationships among the identified variables during coding.
- Map out representations: such as decision mapping and mental models.

3.6.6 Interview guide: pilot testing

To strengthen the legitimacy of the study, a pilot study was conducted with non-participants using a face-to-face interview with the interview questions guide and a semi-structured discussion. In this way, potential gaps in the data collection instrument were identified. Valuable comments and feedback were received and adjustments made to the interview questions guide to ensure that the interview questions were in line with the study participants and, thus, interpreted correctly. Muresherwa and Jita (2022:222) explain that conducting a pilot study has the following advantages:

- It assists the skills developer in identifying gaps, inconsistencies, repetitions as well as mistakes in data collection instruments;
- It aids in the wording of the questions and ensures that no offensive language is used in the questionnaire;
- It enables the skills developer to delete irrelevant questions and rephrase ambiguous ones.
- Non-participants may recommend additional questions that could be included in both the questionnaire and interview process

3.7 Sampling

3.7.1 Target population

Studies by Zikmund (2013:385) refer to a population as a community or segment with a

set of mutual features. A population could also be referred to as a specified section or standard for the skills development study (Cresswell, 2018). In other words, the study population or community defines the whole group of individuals, entities, belongings or events that share some common characteristics that were of interest to skills development. In this study, the sample comprised of NRF I SARAO employees.

The interviews were conducted in the Karoo in an organised and consistent manner. Appointments were arranged with individual participants for different dates and times that were convenient for them. Interviews allowed participants to engage in in-depth discussions relating to the skills development questions. This practice was employed to acknowledge that every interviewee has a different background and, thus, a unique experience of the skills development topic.

Out of 50 purposively-selected participants, 17 responded to semi-structured interviews due to Covid-19 challenges from purposefully selected participants. The Covid-19 pandemic caused challenges to collect the data both on the researcher and participant's side. The use of interviews enabled the skills development to enjoy significant advantages. Interviews enable the skills development to overcome any misunderstandings and misinterpretations on the part of interviewees, thus allowing a rich picture to emerge from their responses. In this study, the interviewees were encouraged to ask for explanations when issues raised in the questions were unclear, thus reassuring and encouraging them to persevere.

3.8 Data analysis

The questionnaires were sorted, coded and entered into Microsoft Excel. Tables for example, frequency tables which display the frequency of each data set in an organised way were used. The tables help researchers to find patterns in the data and also enable data to be analysed using other statistical methods. The Statistical Package for Social Sciences (SPSS) was used to carry out data analysis to accomplish the objectives of this study. The SPSS is more appropriate and suitable for the present qualitative study as responses from respondents can be entered into the software which then analyses the

data to produce meaningful information that can then be presented.

3.8.1 Validity

The construct of a skills development strategy validity refers to the strategic degree to which an instrument scores and reflects the desired outcome. This applies to instruments with multiple indicators, such as questions and interviews. The procedure of assuring the validity of the data collection instruments was essential because it helped to link all these items with the theoretical aspects of the skills development components, thus contributing to construct validity. A selected data instrument should be legally accepted only when it measures what it aims to measure and should be checked to ensure it is fit for purpose. Verification of research objectives, the data instrument(s), and content output also ensures that the particular study is reliable and validated using triangulation in order to collect and analyse data. In addition, the CPUT Ethics Committee checks for validity of instruments before granting ethics clearance.

3.8.2 Prevention of bias

Bias occurs when the skills development instrument(s) do not represent the target population (Babbie & Mouton, 2014:267). Bias in skills development studies refers to any aspect within the study that can compromise the skills development result by misrepresenting specific data or the findings and conclusions of the skills development.

3.9 Ethical considerations

Educational research deals predominantly with human beings, which means that it is imperative to understand not just the legal but also the ethical implications of conducting a research study (Fleming & Zegwaard, 2018). CPUT's Faculty of Business and Management Sciences Research Ethics Committee approved the research proposal and other relevant documents (Appendix 3). Ethical considerations for data collection started with acquiring permission from the participants. Participants were given a consent form to confirm their participation after being fully informed about the study through the consent letter (see Appendix 2). The researcher explained the procedures and protocols for the interviews. In addition, the participants were informed that the interviews were entirely

voluntary and had an option of leaving the study at any time without any penalty. The researcher informed the participants about confidentiality as follows: “information supplied will be used for the purpose of academic research only and will be kept in strict professional confidence”. Participants were also told to omit any questions that made them uncomfortable. They were assured that all the responses recorded would remain confidential and in an encrypted file to which only the researcher would have access.

3.10 Summary

This chapter described in detail the design and methodological aspects of the study. It explained the skills development methodology used to address the skills development study’s philosophy. The questionnaire skills development approach was employed because it allowed for the integration of skills development findings, resulting in an in-depth understanding and interpretation of the phenomenon of skills retention and transfer, the objective of skills development study. Semi-standardised individual interviews were conducted with 17 skills developers who had been selected through non-probability sampling. Data collected during the interviews was analysed through content analysis. The study delineated issues relating to ethical considerations. The next chapter presents and discusses results of the study.

CHAPTER FOUR

RESULTS

4.1 Introduction

The preceding chapter described the study research methodology looking at the theoretical aspects of research approaches, the rationale and the data collection process. This chapter present the results and discussion of the findings. For ease of understanding, the research findings are presented in frequency tables, graphs, and charts. It is vital to note that the skills development project were referred to as respondents. Survey included demographic details that included gender, age range, educational level, and other major components that followed the study objectives.

4.2 Demographic details

4.2.1 Gender

The gender of participants was biased towards male participants: about 71% were males and 29% were females (Table 4.1; Fig. 4.1).

Table 4.1: Gender of the participants

			Percent	Valid Percent	Cumulative Percent
Valid	Female	5	29.4	29.4	29.4
	Male	12	70.6	70.6	100.0
	Total	17	100.0	100.0	

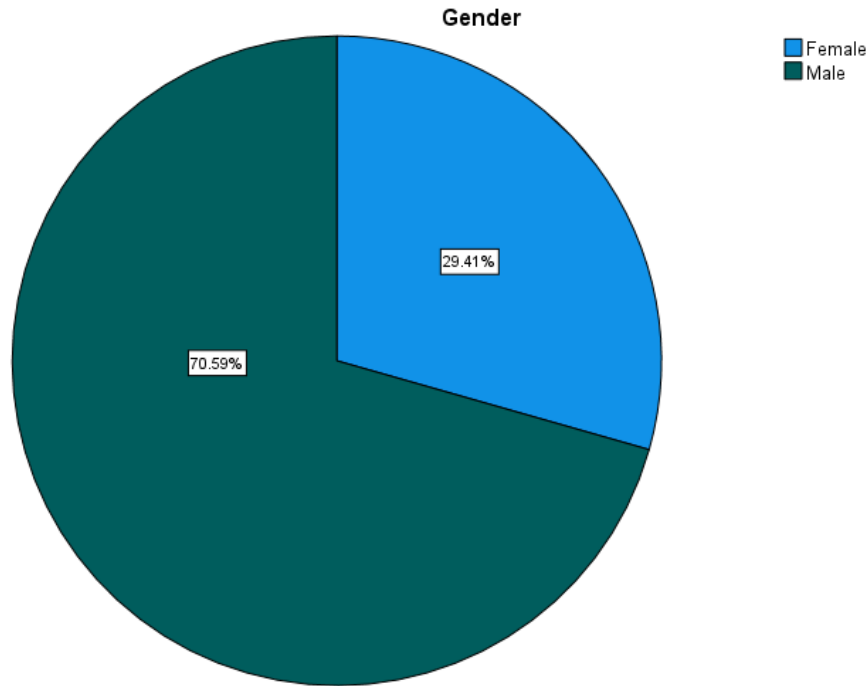


Figure 4.1: Gender of the participants

4.2.2 Age group

In terms of age groups, most participants belonged to the 18-29 year age group, with a percentage of 47.06%, followed by the 30-39 and 50-59 year age groups, both with a percentage of 23.53% each, whilst the 40-49 year age group had the lowest percentage of 5.88%, as shown in Table 4.2 and Fig. 4.2.

Table 4.2: Age group of the participants

	Number	%	Valid %	Cumulative %
18-29	8	47.1	47.1	47.1
30-39	4	23.5	23.5	70.6
40-49	1	5.9	5.9	76.5
50-59	4	23.5	23.5	100.0
Total	17	100.0	100.0	

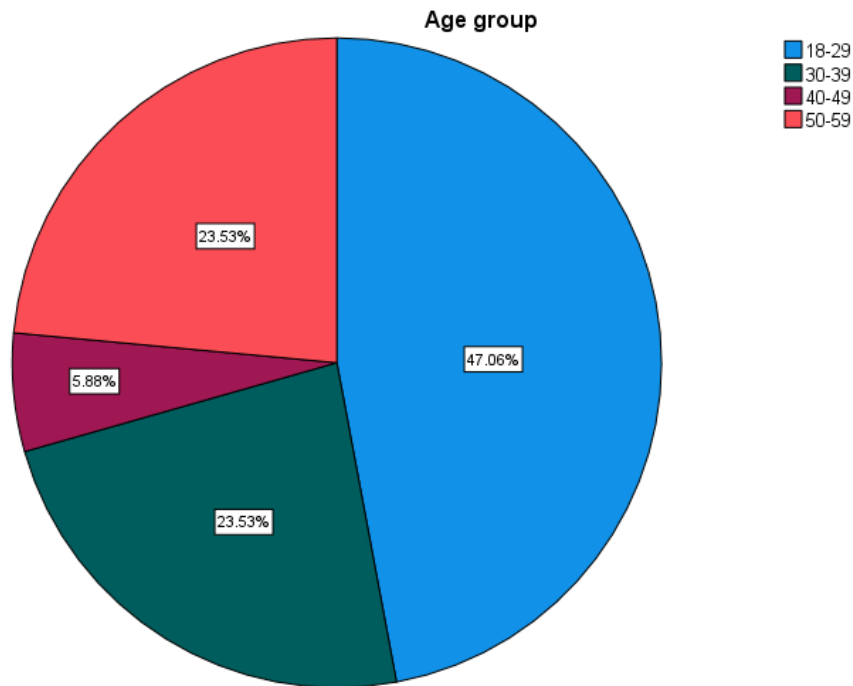


Figure 4.2: Age group of participants

4.2.3 Qualifications

Regarding qualifications, most participants had gone up to the Matriculation and diploma holders topped with 29.4% each, followed by postgraduate degree holders with 23.5% and first degree (17.6%.) as reflected in Table 4.3 and Fig. 4.3.

Table 4.3: Qualification of the participants

	Number	%	Valid %	Cumulative %
Matric	5	29.4	29.4	29.4
Diploma	5	29.4	29.4	58.8
Degree	3	17.6	17.6	76.5
Postgraduate	4	23.5	23.5	100.0
Total	17	100.0	100.0	

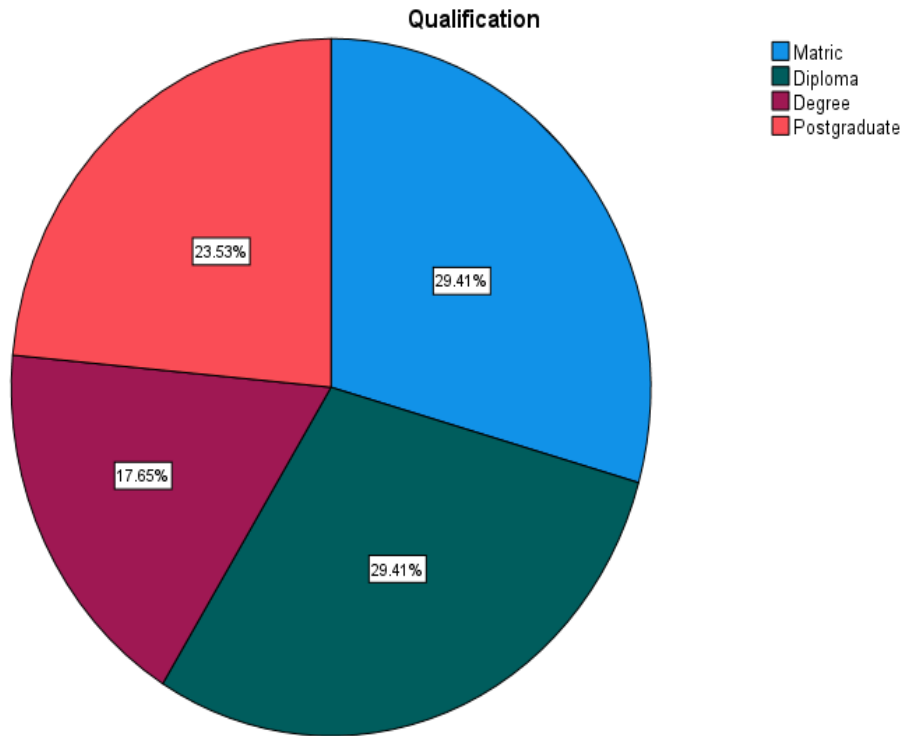


Figure 4.3: Qualifications of participants

4.3 Questionnaire responses

4.3.1 *Development that can be done in the Karoo*

According to the findings in Table 4.4, most respondents expect the SKA project to create or give more working opportunities as shown by the high percentage of 47.1% compared to other responses. The next popular response was “Equip farmers and farmworker” at 11.8%. All the other responses were uniform at 6% each: accommodation provision in cities, broaden skills development fields, Build a FVET college in Carnarvon, more options in the bursary programmes, give school bursaries not only based in Carnarvon and get a bigger training centre.

Table 4.4: Developments that can be made to the Karoo and how to make the skills development programmes effective

	Frequency	%	Valid %	Cumulative %
Accommodation in cities	1	5.9	5.9	5.9
Broaden skills development fields	1	5.9	5.9	11.8
Build a FVET college in Carnarvon	1	5.9	5.9	17.7
Create or give more working opportunities	8	47.1	47.1	64.7
Equip farmers and farmworker	2	11.8	11.8	76.5
Get a bigger training centre	1	5.9	5.9	82.4
More options in the bursary programmes, give school bursaries not only based in Carnarvon.	1	5.9	5.9	88.3
None	2	11.8	11.8	100.0
Total	17	100.0	100.0	

4.3.2 What type of skills does NRF|SARAO need in the Karoo?

Table 4.5 shows the type of skills the NRF|SARAO would need in the Karoo as perceived by respondents. The artisans and engineers trades were mentioned the most with a percentage of 52.9%, followed by office workers with a percentage of 29.4%. None and farm technicians received the least at 11.8% and 5.9%, respectively.

Table 4.5: Type of skills needed by the NRF|SARAO in the Karoo

	Frequency	%	Valid %	Cumulative %
Artisans and engineers	9	52.9	52.9	52.9
Office workers	5	29.4	29.4	82.3
Farm technicians	1	5.9	5.9	88.2
None	2	11.8	11.8	100.0
Total	17	100.0	100.0	

4.3.3 HCD programmes that the NRF|SARAO is implementing in the Karoo

Majority of respondents were aware of programmes the NRF|SARAO is implementing in the Karoo (Table 4.6). A combined percentage of 58.8% listed artisans and engineering training programmes and bursaries provisions to students as the HCD programmes being implemented by the NRF|SARAO. A significant percentage of 29.4% did not know of any programmes being implemented in the Karoo for HCD.

Table 4.6: HCD programmes being implemented by the NRF|SARAO in the Karoo

	Frequency	%	Valid %	Cumulative %
Artisans and engineering training programmes	5	29.4	29.4	29.4
Bursaries for students	5	29.4	29.4	58.8
Cultural development and language integration	1	5.9	5.9	64.7
Farmers and workers awareness campaign.	1	5.9	5.9	70.6
None	5	29.4	29.4	100.0
Total	17	100.0	100.0	

4.3.4 Reasons skills development HCD programmes were developed

Table 4.7 summarises the responses of participants on the reasons skills development

HCD programmes were developed and implemented. Most respondents indicated that the reasons the HCD programmes were developed and implemented were to empower local communities and to provide them with jobs, with a combined percentage of 64.7%. Other responses, including to experience and growth to achieve growth for NRF|SARAO; make the community part of the NRF|SARAO; raise awareness in farming communities; had low percentages of 5.9% each.

Table 4.7: The reasons for developing and implanting skills development HCD programmes

	Frequency	%	Valid %	Cumulative%
Create job opportunities	5	29.4	29.4	29.4
Empower individuals from rural communities	6	35.3	35.3	64.7
Experience and growth to achieve growth for NRF SARAO	1	5.9	5.9	70.6
For the community to be part of the project, everything is usually outsourced.	1	5.9	5.9	76.5
Make the community part of the NRF SARAO	1	5.9	5.9	82.3
Raise awareness in farming communities	1	5.9	5.9	88.2
None	2	11.8	11.8	100.0
Total	17	100.0	100.0	

4.3.5 The main beneficiaries of HCD programmes

Table 4.8 indicates the constituents who are the main beneficiaries of HCD programmes. Local communities had the highest percentage of 52.9%, followed by learners and young adults, and youth from the Karoo with a combined percentage of 35.3%.

Table 4.8: Main beneficiaries of HCD programmes

	Frequency	%	Valid %	Cumulative %
Everyone in the community	9	52.9	52.9	52.9
Learners and young adults.	4	23.5	23.5	76.4
Youth from the Karoo	2	11.8	11.8	88.2
Students	1	5.9	5.9	94.1
Young unemployed adults and school learners	1	5.9	5.9	100.0
Total	17	100.0	100.0	

4.3.6 How the programmes work

Table 4.9 shows responses of the participants on how they could be involved in the programme at NRF|SARAO. The results show that most people apply even when they do not know what the course or programme is about. This response had the highest percentage (29.4%), followed by Apply for the bursary with 11.8%. The other responses that include: apply with matric results; matric, qualify and then get a bursary; none; you go for an interview before bursaries are being awarded to successful candidates; you just have to gain 40% in each of your subject; each had minimal responses of 5.9%.

Table 4.9: How the programmes work

	Frequency	Percent	Valid Percent	Cumulative Percent
A programme is advertising and individuals apply	1	5.9	5.9	5.9
Apply for the bursary	2	11.8	11.8	17.7
Apply even when you do not know what the course is about	5	29.4	29.4	47.1
Apply with matric results	1	5.9	5.9	53.0
By applying and filling in the forms	1	5.9	5.9	58.8
Community meetings and information session	1	5.9	5.9	64.7
Learners apply for the programmes and he/she get accepted for the programme and trained for a four-year time span.	1	5.9	5.9	70.6
Matric, Qualify and then get a bursary	1	5.9	5.9	76.5
None	1	5.9	5.9	82.4
Students and learners from the surrounding areas are put into the programmes and trained.	1	5.9	5.9	88.3
You go for an interview before bursaries are awarded to successful candidates.	1	5.9	5.9	94.1
You have to gain forty percent in each of your subjects	1	5.9	5.9	100.0
Total	17	100.0	100.0	

4.3.7 How effective have these programmes been in fulfilling their objectives?

Table 4.10 describes how effective these programmes have been in fulfilling community objectives. Most responses regarded the effectiveness of the programmes as neither effective nor non-effective with a percentage of 35.3%. This was followed by respondents who regarded the programmes as very effective (29.4%); very ineffective (17.6%); highly ineffective (11.8%) and highly effective (5.9%) (Fig. 4.4).

Table 4.10: Effectiveness of HCD programmes in fulfilling their objectives

	Frequency	%	Valid %	Cumulative%
Highly effective	1	5.9	5.9	5.9
Very effective	5	29.4	29.4	35.3
Neither effective nor non-effective	6	35.3	35.3	70.6
Very ineffective	3	17.6	17.6	88.3
Highly ineffective	2	11.8	11.8	100.0
Total	17	100.0	100.0	

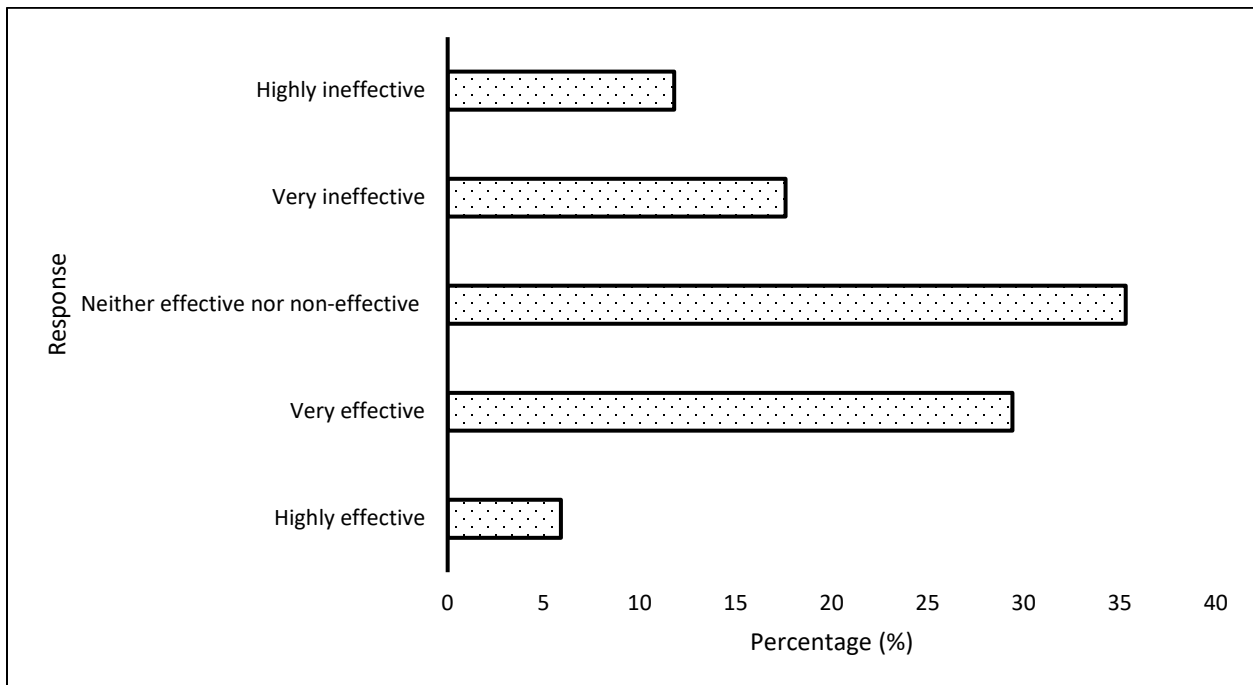


Figure 4.4: Effectiveness of HCD programmes in fulfilling their objectives

4.3.8 Strengths and weaknesses of the skills development programmes

The number of weaknesses that were identified by the respondents were more than the number of strengths for the skills development programmes. The responses comprised 56.5% weaknesses and 43.5% strengths (Fig. 4.5; Table 4.11 and 4.12).

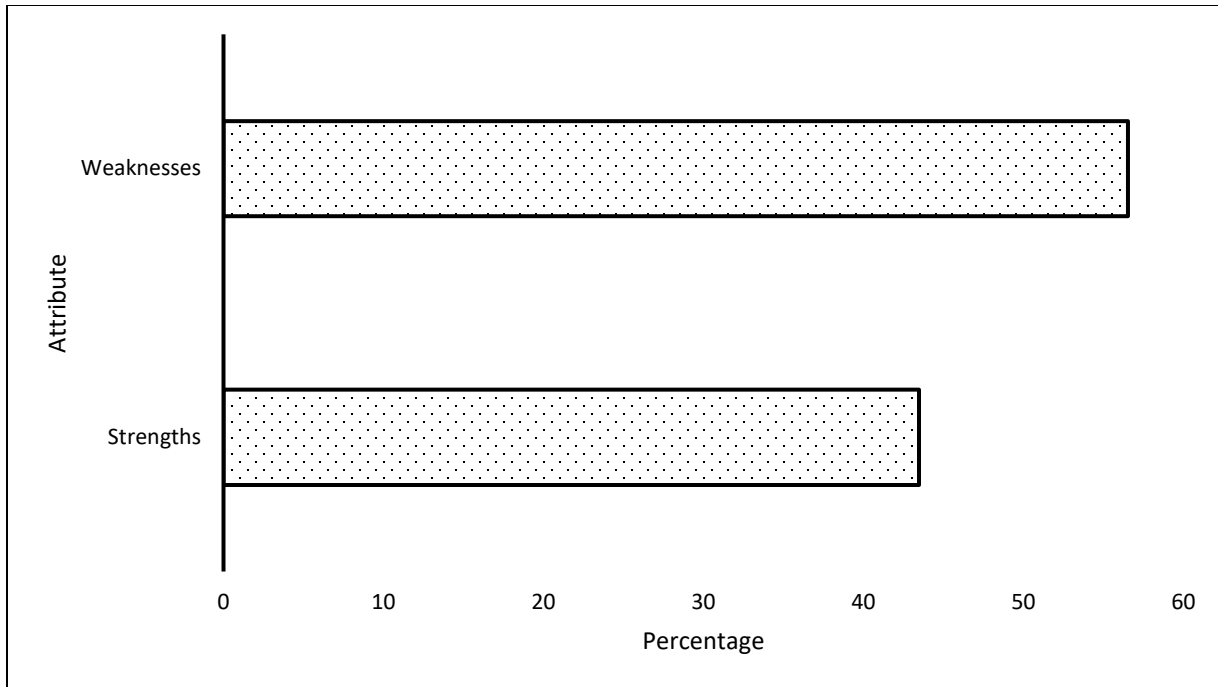


Figure 4.5: Comparison of strength and weaknesses of the skills development programmes

Table 4.11 summarises the strengths of the human capacity skills development programmes currently implemented at NRF|SARAO. All responses were fairly similar in terms of percentage response. The highest responses had a percentage of 11.8% and these were: builds up capacity skills, sharpens instincts and enhancing capacity; NRF|SARAO give more experience; bursaries from primary school; teamwork involving the community members of the Karoo; get a full bursary, travelling and exposure; and good chance of receiving permanent employment.

Table 4.11: Strengths of the HCD programmes currently implemented at NRF|SARAO

	Frequency	Percent	Valid Percent	Cumulative Percent
None	1	5.9	5.9	5.9
Builds up capacity skills, sharpens instincts and enhancing capacity	2	11.8	11.8	17.7
NRF SARAO give more experience	2	11.8	11.8	29.4
Bursaries from primary school	2	11.8	11.8	41.2
Physically present and developing skills and furthering community	1	5.9	5.9	47.1
NRF SARAO make sure that they appoint qualified maths, physical science teachers	1	5.9	5.9	53.0
Teamwork involving the community members of the Karoo	2	11.8	11.8	64.7
Get a full bursary, travelling and exposure	2	11.8	11.8	76.5
Presence of a training centre in the Karoo	1	5.9	5.9	82.4
The understanding of the radio frequency operations	1	5.9	5.9	88.3
Good chance of receiving permanent employment	2	11.8	11.8	100.0
Total	17	100.0	100.0	

The highest percentage of weakness from the respondents was that there is no guarantee that the NRF|SARAO will employ them after the programme, which had a percentage of 17.6%, followed by the high unemployment rate regardless of good qualifications with 11.8% of the responses. Students also fail their bursaries as described by the respondents together with other weaknesses as described in Table 4.12, each of which contributed 5.9%.

Table 4.12: Weaknesses of the HCD programmes currently implemented at NRF|SARAO

	Frequency	Percent	Valid Percent	Cumulative Percent
Lack of diversity in the programmes	2	11.8	11.8	11.8
Students that fail lose their bursaries	1	5.9	5.9	17.7
Unemployment rate is high, not enough personnel with good qualifications	2	11.8	11.8	29.4
Language barrier and human factor	1	5.9	5.9	35.3
Success rate at the end of the programme are enormously low	1	5.9	5.9	41.2
There is no guarantee that NRF SARAO will employ you	3	17.6	17.6	58.9
Farm workers lost their jobs and habitats	1	5.9	5.9	64.7
Lack of equipment in their facilities	1	5.9	5.9	70.6
Lack of information being shared	1	5.9	5.9	76.5
The age restriction on the programme	1	5.9	5.9	82.4
The selection criteria	1	5.9	5.9	88.3
They have a very small success rate	1	5.9	5.9	94.2
They do not give you the full theoretical training	1	5.9	5.9	100.0
Total	17	100.0	100.0	

4.3.9 Factors that have hindered the effectiveness of these programmes

Owing to the weaknesses of the HCD programmes currently implemented at NRF|SARAO, Table 4.13 summarises the factors that have hindered the effectiveness of these programmes. Among the responses, was the fact that the NRF|SARAO does not put the Karoo person first, which had a percentage of 29.4%, followed by no access to information with a percentage of 23.5%. Other responses each contributed 5.9%.

Table 4.13: Factors that have hindered the effectiveness of these programmes

	Frequency	Percent	Valid Percent	Cumulative Percent
No access to information	3	17.6	17.6	17.6
Access to information	1	5.9	5.9	23.5
Student does not feel welcome	1	5.9	5.9	29.4
Financial constraints	1	5.9	5.9	35.2
No exposure to workshop environment, practice on equipment	1	5.9	5.9	41.1
None	1	5.9	5.9	47.0
Poor selection criteria	1	5.9	5.9	52.9
NRF SARAO not putting the Karoo person first	4	23.5	23.5	76.4
No job guarantee after completion of the programmes	1	5.9	5.9	82.3
The equipment that they have is not enough	1	5.9	5.9	88.2
Too much academic focus, it should be passion and ambition	1	5.9	5.9	94.1
Unemployment and access to information	1	5.9	5.9	100.0
Total	17	100.0	100.0	

4.3.10 What the NRF|SARAO can implement to develop skills

Table 4.14 shows a review on kinds of programmes NRF|SARAO can implement to develop skills. The respondents suggested that the NRF|SARAO should create more job opportunities and to provide courses for everyone that include hairdressing, cooking, baking, nails and beauty, which are not directly related to the SKA project. These two responses contributed 58.8% of the total responses.

Table 4.14: What the NRF|SARAO can implement to develop skills

	Frequency	Percent	Valid Percent	Cumulative Percent
Creating more job opportunities	5	29.4	29.4	29.4
Develop roads, buildings and other infrastructure	1	5.9	5.9	35.3
Do not bring maths teachers from other towns	1	5.9	5.9	41.2
Early skills training before studies	1	5.9	5.9	47.0
Online training and computer literacy	1	5.9	5.9	52.9
Provide courses for everyone to include hairdressing, cooking, baking, nails and beauty etc.	5	29.4	29.4	82.3
Sports and agriculture	1	5.9	5.9	88.2
Train farmers and workers the latest astronomy development	1	5.9	5.9	94.1
None	1	5.9	5.9	100.0
Total	17	100.0	100.0	

4.4 Length of services or involvement in the project

Table 4.15: Length of services or involvement in the project

			Statistic	Std. Error
Length of services or involvement in the project	Mean		4.94	.699
	95% Confidence Interval for Mean	Lower Bound	3.46	
		Upper Bound	6.42	
	5% Trimmed Mean		4.93	
	Median		5.00	
	Variance		8.309	
	Std. Deviation		2.883	
	Minimum		0	
	Maximum		10	
	Range		10	
	Interquartile Range		4	
	Skewness		.155	.550
	Kurtosis		-.445	1.063

Table 4.15 shows a review on the length of services or involvement in the project. The mean length of services/involvement in the SKA project was 4.9 years (Fig. 4.6).

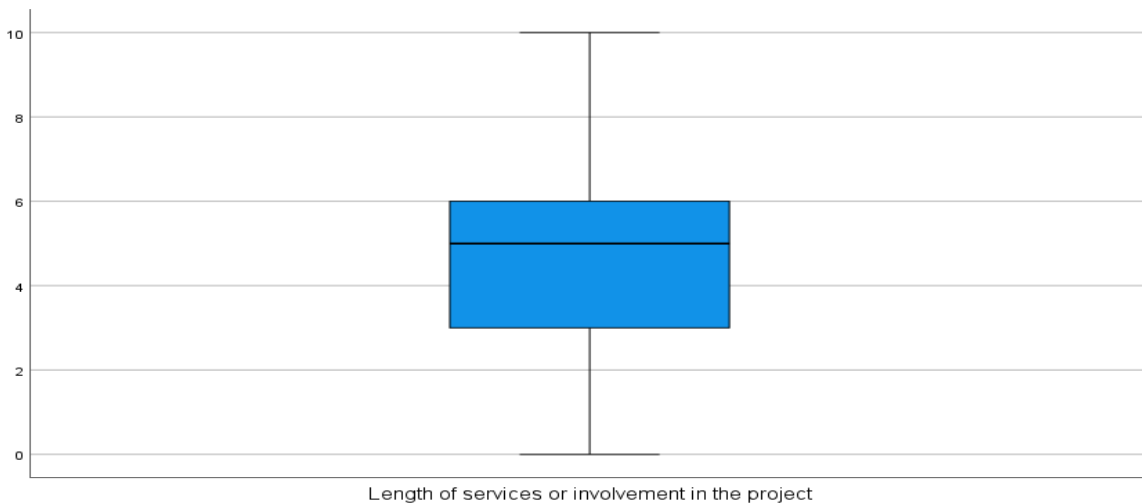


Figure 4.6: Length of services or involvement in the project

4.5 Objective-based discussion

A skills development programme in engineering is essential in every sector. Addo-Tenkorang (2011) states that concurrent engineering (CE) approaches have fundamentally transformed how the implementation of technology companies in the Northern Cape and new products are being developed in concurrent engineering companies and that has not always been proved easy as stated by (Kaur et al., 2019). The principles of CE have become vaguer because the core concepts that define the popularity of this type of engineering have grown and their application has become more diverse (Addo-Tenkorang, 2011). Kuar et al. (2019) state that evolution in Narcissistic Personality Disorder practices and explain that global competition has led shorter product life cycles and CE represents a dramatic evolution skills developers.

4.5.1 Programmes are being offered by the NRF|SARAO for community development

Van der Hoef (2017) state that the SKA project will established the Karoo and led to hope among a wide cross- section of the Karoo communities that this would bring about the economic relief that this area desperately needs, it is not surprising that given the problems around high unemployment rates, poor education and alcoholism and domestic violence is not surprising around the SKA project.

The socioeconomic conditions in the Northern Cape Province have already developed projects and urgently needed local community to make it more evident and the workforce development skills will take place in the surrounding area, the educational statistics on the education levels and the field of specialty of the SKA project emphasise the pressing need for the initiatives development, concentrating on education and gain access to technology (van der Hoef, 2017). When the SKA project idea was first introduced to the communities in the Karoo region in 2008, SKA officials declared that the project would drive the confined monetary progress, the manufacture of jobs and developed prospects for the youths over the upgrade of education and science (Wild, 2016). Van der Hoef (2017) state that the Siyafunda Computer Technology Centre (SCTC) at the local Kareeberg library are one of the several projects that are being run with SKA support, most concentrated in Carnarvon.

This is besides the school programmes that the SKA supports. In the SKA public information booklet, over 1000 jobs have already been created just from the construction work and upgrading of the infrastructure between Losberg site and Carnarvon where the satellite dishes are being built (SKA-SA, 2016). Studies by (SKA SA, 2016) state that road construction and subcontractors for work have been reported, that local business owners and contractors have been funded and trained to submit for tenders.

4.5.2 Effectiveness of the skills development programmes currently being implemented by the NRF|SARAO

The programmes and opportunities described above show gaps in fulfilling these claims as there is a wide criticism of initiatives implemented by the SKA. According to this study, the effectiveness of programmes in fulfilling their objectives ranged from highly ineffective and highly effective. Among the main complaints was that the NRF|SARAO does not put Karoo's people first. This is of concern as the SKA project was introduced to the Karoo communities' doorstep and should be prioritised in terms of SKA opportunities. However, the SKA project requires highly skilled labour, which is currently in short supply globally. Many countries have continuously expressed how they are not satisfied with the shortage of skilful experts in the sectors of their economic activities (Mateus et al., 2014:63).

Nonetheless, this could be an issue in the Northern Cape whereby highly skilled labour for specialised positions is lacking and hence the decision by the SKA to hire skilled labour from different regions as the SKA needs to get running and achieve its national as well as global targets. Having tertiary education increases the understanding of the technology and engineering industry, which is one of the key drivers of creating jobs and promoting economic growth worldwide. Therefore, it is imperative to encourage individuals with matric to take courses related to SKA operations to enhance their knowledge and skills, thereby promoting personal development. Plaatjies & Mitrovic (2014) explain that several government initiatives address the skills challenges facing. Technology and engineering companies in the Republic of South Africa have an inconsistency of the high unemployment due to the current skills shortage, growth opportunities capitalize on basic and higher education institutions, however- engineering and technology firms focus on empowering employees to build a highly experienced workforce required capitalise on growth opportunities (Plaatjies & Mitrovic, 2014).

Wild (2016) confirm the already stated fact that the Karoo comprises widespread farming and rural areas and that great poverty exists in its under-developed towns, thus exacerbating the problem facing RSA in ensuring the transfer and retention of specialist skills.

4.5.3 Strengths and weaknesses of the programmes being offered by the NRF|SARAO

Inarguably, a shortage of highly skilled labour in the Northern Cape region motivated the SKA project to include skills and human resource development programmes as part of its community development mandate. The SKA project aims to empower Karoo communities, particularly the youth, by providing training opportunities and bursaries for them to be part of SKA projects (van der Hoef, 2017). The communities are aware of these initiatives by the NRF|SARAO. There were, however, a few issues raised with regard to how the initiatives are being implemented, which mainly have to do with the fact that the programmes and bursaries are only in the field of SKA projects. The programmes lack of diversity, as mentioned by some of the respondents, and are focused on SKA-

related work, rather than community members' personal passion and ambition. Some respondents even suggested that the NRF|SARAO should expand its support to non-technical courses for the support to be inclusive of everyone by including hairdressing, cooking, baking, nails and beauty courses and training centres to cater for individuals who cannot make it into the engineering field.

Van der Hoef (2017) state that the bursary programmes is well known in the Karoo towns and not everyone is in favour about the initiative. In the year 2015-2016 the SAROA/NRF project has sponsored five (5) students who has achieved university admission passes in their final matric results 2015, in the following subjects: science, maths etc. with bursaries to study engineering related degrees at universities in South Africa (van der Hoef, 2017). The commonly expressed opinion within the community was that if one is not good in maths and science, it means they are excluded from the bursary programme. This also adds to the exclusiveness of the NRF|SARAO programmes, which are maths and science centred. Accepting NRF|SARAO bursaries to engineering courses are also faced with mixed perceptions from the communities in the Karoo region as students fear losing bursaries along the study period, as the NRF|SARAO has strict policies on students that fail. This policy is a common agreement between students and funders here in South Africa, but the Karoo communities suggested that bursaries be awarded to potential students without any restrictive agreements.

The issue of gender equality was not mentioned in any of the responses, but the fact that the NRF|SARAO focuses most on science and engineering programmes excludes a significant number of female candidates. Due to well-known cognitive biases, many people often reach erroneous conclusions and develop stereotypes and prejudices. For example, in job applications, female applicants are expected to be less likely to be committed, less self-confident and less likely to stay on a job than male applicants (Heilman, 2012). Many factors contribute to gender inequality globally, and gender bias in workplaces plays an important role (Martínez et al., 2021:1). On the other hand, personal choice is also a dominant reason for the underrepresentation of women in technology and math-related fields (Swift & Stillwell, 2015:515). Women may choose not

to pursue technology or math-related careers due to a lack of interest or because they do not see the science, technology, engineering and math (STEM) fields fitting in with their personal goals (Swift & Stillwell, 2015:515). There are some pretty damning statistics showing a massive difference in attitudes towards technology careers for females and males (Dunne, 2021). Therefore, it is not a surprise that the technology sector is highly desperate to hire more females to bring a balance to the industry. The NRF|SARAO can help avert these gender biases by encouraging girls to take technology-related courses at high school and university. They can offer school educational sessions and highlight women's value in their workplace. Companies should also offer to create gender-neutral job descriptions, offer female-friendly job benefits and provide competitive and fair salaries to females (Dunne, 2021).

Studies by Lee et al. (2009) have created new skills and task content of jobs and on-going technological developments, for example: skills requirements and task content of jobs and reshaping the production processes. Some respondents also mentioned the issue of age restriction as one of the factors affecting HCD programmes that are available by the NRF/SARAO in this modern world.

Highly skilled and well- trained workers are rapid technological change and the transition to knowledge- based economies will increase the demand for highly skilled and well trained workers. Workers use computer connected to the internet or some other form of gadget and technology at work, and this number is expected to grow as will the scope of sophistication of technology. Studies by Lee et al. (2009) state that these age related changes in abilities the literature indicates that older adults can learn new skills, this implies that older workers who may not have been exposed to the changes in technology will need continuous training to remain competitive in the workforce. Although it takes them longer than younger adults, requiring practice and environment support.

4.5.4 Programmes the NRF|SARAO should implement to develop the Karoo communities

The respondents expect the NRF|SARAO to do more and provide more opportunities to most local communities of the Karoo. Some of suggestions by the respondents have been

discussed in previous sections. One notable response was that the NRF|SARAO should invest more effort in communicating exactly what is offered and the requirements. This helps to increase participation in programmes as well as to fully support SKA projects. Communities should, however, be sensitised to the fact that the NRF|SARAO has a mandate and that it cannot undertake all educational development. There are other NRF institutes that could be engaged to cover some of the limitations of the NRF|SARAO, but this needs to be communicated well to communities so that they do not negatively regard the NRF|SARAO programmes. Actions the NRF|SARAO could take include:

- Low entry requirements expected by community;
- More training fields expected;
- More subject choices expected; and
- More career counselling.

4.6 Importance of skills retention and skills transfer in the Karoo

The company environment and the degree of comfort an employee feels within it affect the length of time an employee is involved in a project, employees spend a long period of their career with a company until some force causes them to leave and the mean length of service involved SKA project was 4.9 year. The strength or weakens the desire of the worker to continue working on that particular project, the degree of compatibility between a worker's values and work ethics which the company stands for. The employee's ethics are derived from the encounters on the job and from his/her values and the conditions he/she has encounter on the job, and the policies and procedures of the managing project on the other hand the company's value are derived from the societal norms decisions and by the formal directors.

The technology and engineering sector in the Karoo and its retention challenges are being explained in this study. The Qualification Authority Act of 1995 (No. 58) in South Africa introduced a framework to rise opportunities for learners and improve their qualifications through the portability of existing credentials, thus providing them with access to enhanced employment opportunities. However, many vacancies for experienced employees remain unfilled due to the continuing lack of skills retention and transfer

programmes (Rasool & Botha, 2011:1). Efforts to avert this shortage of essential skills could be solved by introducing changes in the schools and tertiary institution's curriculum. However, this deficiency remains because of the lack of skills retention, transfer databases in technology and engineering companies, and SKA could also be affected. This highlights the major obstacles faced by the public and private sectors regarding job creation and economic growth in RSA. Both the government and trade unions frequently draw attention to these problems via the media, leading to criticism from employer bodies and other stakeholders.

4.7 Summary

This chapter presented results of the study and further discussed them in detail with a view to linking them to the research objectives and questions. The discussion evaluated the SKA project, how it has benefited the Karoo communities and various factors affecting implementation of the programmes offered for skills and community development. The next chapter concludes the study and makes recommendations to both the NRF|SARAO and Karoo communities so that both parties benefit from the mutualistic relationships.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Projects like these are often associated with social impacts and involving local communities in such projects increases their success rate. Owing to the social responsibility of the SKA, there was a need to investigate the communities' awareness of programmes and opportunities available to them, and how they perceive these opportunities. The conclusions are based mainly on the propositions presented in Chapter 1, which are reproduced in this chapter to determine which were confirmed and rejected based on the research results.

5.1.1 Proposition 1: The communities are aware of programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa.

This study found that communities are aware of programmes the NRF|SARAO is implementing in the Karoo. These include: primary and high school bursaries, undergraduate and graduate bursaries, and artisan training. The beneficiary blanket for the SKA HCD programmes is wide and described by respondents as mostly the youth of the Karoo who are likely to benefit. The study acknowledges the initiatives by the SKA to empower local communities by offering them opportunities. Offering the communities bursaries and training opportunities has an overall positive outcome of preventing the shortage of specialised human resources in a world that is orienting its operations towards technological advancement. Some respondents, however, expressed deep concern over the way these programmes are implemented as well as requirements, which often exclude candidates who are not good in Mathematics and Science. There is inadequate communication on the part of SKA with regard to these programmes and opportunities. Results of study accept this proposition as communities were aware of programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa.

5.1.2 Proposition 2: The skills development programmes currently being

implemented by the NRF|SARAO in the Karoo, South Africa are highly effective.

The participants had varying responses with regard to the effectiveness of the programmes. The responses varied between highly effective by most respondents to not effective at all. One respondent said the HCD programme is not effective at all because students fail and lose their bursaries, which is standard practice in bursary programmes globally, except under certain acceptable conditions. This should be clearly communicated to students so that they understand the consequences of not working hard for the opportunity given to them. Results from the study, therefore do not support proposition 2, as respondent regarded the skills development programmes currently being implemented by the NRF|SARAO in the Karoo as not highly effective.

5.1.3 Proposition 3: The number of strengths and weaknesses of the programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa, are equal

With regard to the strengths and weaknesses of programmes being offered by the NRF|SARAO, number of weaknesses described by the respondents were more than the number of strengths. The weaknesses mainly had to do with the way SKA programmes are being implemented, which are discriminatory to potential candidates, and communities end up disregarding the programmes. The most mentioned weakness by the respondents was that there is no guarantee the NRF|SARAO will employ them after the programme. This gives communities uncertainty and lowers their motivation to participate in the SKA programmes. Based on the results, the study does not accept this proposition as the number of strengths and weaknesses of the programmes being offered by the NRF|SARAO for community development in the Karoo, South Africa, were not equal.

5.2 Recommendations

This study has noted major challenges associated with the SKA project in the Karoo region. It is important to document and understand these issues deeply in order to promote a harmonious atmosphere with both the communities and the SKA benefiting. The weakness to strength ratio of programmes offered by the SKA project should be very

low with strengths dominating more than the weaknesses. It is up to the SKA to look at the weaknesses, address them and reach out to the community. The strengths should also be assessed so that the effectiveness of programmes is enhanced. Based on the conclusions per the propositions, the following recommendations are made:

5.2.1 NRF|SARAO

To determine the programmes the NRF|SARAO should implement to develop the Karoo communities of South Africa, the NRF|SARAO should:

- give a chance to individuals with low entry requirements.
- diversify its programmes and provide more training fields.
- improve its communication channels to the communities with regard to the programmes they offer.
- reflect on the promise they made and review them to determine how much they have achieved, which should be publicly available
- collaborate with various departments in South Africa to effectively implement its programmes.
- intensify its efforts to empower females at grassroots levels in order to support the global calls to include and prioritise women.

5.2.2 Karoo communities

It is recommended that the Karoo communities:

- Work hard to compete for the NRF|SARAO programmes as at the end of the day, the NRF|SARAO should be accountable.
- Develop positive attitude towards the NRF|SARAO programmes and understand that NRF|SARAO has a limited mandate, cannot do all developments and other NRF institutes could be engaged to cover some of the limitations of the NRF|SARAO.
- Maximise their involvement in the SKA project as the NRF|SARAO is mandated to support communities.

- Be innovative and work on other independent enterprises that could be beneficial for the NRF|SARAO employees, for example, markets and food stores in order to generate income for themselves.

5.2.3 Research

While this study gives a snapshot of skills and human resource development programmes offered by the NRF|SARAO to Karoo communities, further investigations are required. Nonetheless, the study was conducted during the Covid-19 pandemic with limitations in sample size and opportunities, information post Covid-19 could be useful. The developmental programmes offered by the NRF|SARAO need to be compared with other regional development programmes to determine where South Africa stands with regard to community development.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE INTERVIEW QUESTIONS

1. What should NRF|SARAO do to develop the Karoo and make the skills development programmes effective?

2. What kind of programmes can NRF|SARAO implement to develop skills?

3. What are the skills development programmes for the community members and the employees of NRF|SARAO social responsibilities?

4. What are the strengths and weaknesses of the human capacity skills development programmes currently implemented at NRF|SARAO?

5. In your opinion, what are the factors that have hindered the effectiveness of these programmes?

6. What would you say are the weaknesses of these programmes currently in place?

7. What are the reasons skills development HCD programmes were developed and implemented?

8. Can you tell me a bit about HCD programmes that the NRF|SARAO is implementing in the Karoo?

9. Who are the main beneficiaries of these programmes?

10. How do the programmes work?

11. In your opinion, how effective have these programmes been in fulfilling their objectives?

12. In your opinion, what type of skills does an organisation such as NRF|SARAO need in the Karoo?

13. In your opinion, how effective has the HCD programmes been in fulfilling their objectives?

APPENDIX 2: ETHICS INFORMED CONSENT FORM

CONSENT TO PARTICIPATE IN A SKILLS DEVELOPMENT STUDY

Faculty of Business and Management Sciences

CONSENT TO PARTICIPATE IN A SKILLS DEVELOPMENT STUDY

Category of Participants (tick as appropriate):

<i>Staff/Workers</i>		<i>Teachers</i>		<i>Parents</i>		<i>Lecturers</i>		<i>Students</i>	
<i>Other (specify)</i>									

You are kindly invited to participate in a skills development study being conducted by [Naslyne Andreas] from the Cape Peninsula University of Technology. The findings of this study will contribute towards (tick as appropriate):

<i>An undergraduate project</i>		<i>A conference paper</i>	
<i>An Honours project</i>		<i>A published journal article</i>	
<i>A Masters/doctoral thesis</i>	✓	<i>A published report</i>	

Selection criteria

You were selected as a possible participant in this study because you are:

- The main reason for conducting this skills development is to build academic knowledge in “skills development strategies in rural communities by multifunctional projects like Square Kilometre Array (NRF|SARAO)”.

- Square Kilometre Array (SKA) are being considered to partake in this skills development study as a sense of academic empowerment as well to increase knowledge about “skills development strategies in rural communities”.

The information below gives details about the study to help you decide whether you would want to participate. **Title of the skills development:** A skills development strategy for a selected for a selected technology company in the Northern Cape.

A brief explanation of what the skills development involves:

A global technology project based in the Northern Cape seeks to construct the Square Kilometers Array (SKA) radio telescope, with over a square kilometer accruing astronomical. Participating organizations drawn from eleven (11) countries are currently participants working on the project. The karoo was chosen as site for the project due to non-radio interference with signals from mobile communication, GPS satellites, Air traffic and WIFI (Crowling, et al, 2015:105). The site is also one of the quietest places in the World, with widespread ground economically reliant on sheep agri-business that has presented a countless compact of labour during the last twenty (20) years. The Karoo is largely immature, mainly missing manufacturing including experience workers, in the engineering Mechanical, Civil, Electronic, Metallurgic and Artisans, Electricians, boilermakers, fitter and turners, and fibre technicians.

Procedures (*Interview or Self-administer questionnaire otherwise create your own*)

If you volunteer to participate in this study the following were done:

- Describe the main skills development procedures to you in advance, so that you are informed about what to expect;
- Treat all interviewees with respect by arriving on time for all the interview schedules and well prepared;
- Conduct an introduction with the interviewee in order to break ice;
- All the interviewees were asked for permission to record the interviews and also take some note where applicable;

- In a mixed where there is no clarity, the interviewees were allowed to ask for confirmation or clarity of words/sentences/phrases to ensure accuracy of the data collected;
- Participants were told that their data were treated with full confidentiality and that, if published, it was not be identifiable as theirs;
- Participants were given the option of omitting questions they do not want to answer or feel uncomfortable with;
- Participants were told that questions do not pose any realistic risk of distress or discomfort, either physically or psychologically, to them;
- At the end of each interview all the interviewees were thanked for their time and information provided for this study;
- Participants were debriefed at the end of their participation (i.e. give them a brief explanation of the study).

You are invited to contact the skills developers should you have any questions about the skills development before or during the study. You were free to withdraw your participation at any time without having to give a reason.

Kindly complete the table below before participating in the skills development.

Tick the appropriate column		
Statement	Yes	No
1. I understand the purpose of the skills development.		
2. I understand what the skills development requires of me.		
3. I volunteer to take part in the skills development.		
4. I know that I can withdraw at any time.		
5. I understand that there was not be any form of discrimination against me as a result of my participation or non-participation.		
6. Comment:		

Please sign the consent form. You were given a copy of this form on request.

Signature of participant	Date

Skills developments

	Name:	Surname:	Contact details:
1.	Naslynne DP	Andreas	0788291419 Naslynneandreas2@gmail.com
2.			
3.			

Contact person: Naslynne Dlamini Perseverance	
Contact number: 0788291419	Email: naslynneandreas2@gmail.com

APPENDIX 3: ETHICAL CLEARANCE FROM THE UNIVERSITY



P.O. Box 1906 • Bellville 7535 South Africa • Tel: +27 21 4603291 • Email: fbmsethics@cput.ac.za
Symphony Road Bellville 7535


Office of the Chairperson Research Ethics Committee	FACULTY: BUSINESS AND MANAGEMENT SCIENCES
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The Faculty's Research Ethics Committee (FREC) on **20 October 2020**, ethics **Approval** was granted to **Naslyne Andreas (213301350)** for a research activity **M Tech: Business Information Systems** at Cape Peninsula University of Technology.

Title of dissertation/thesis/project:	A skills development strategy for a selected technology company in the Northern Cape Lead Supervisor (s): Dr D Onojaefe / Dr S Kasse
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Comments:

Decision: **APPROVED**

 Signed: Chairperson: Research Ethics Committee	3 November 2020 Date
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Clearance Certificate No | 2020FOBREC825

APPENDIX 4: LANGUAGE EDITING LETTER

SD Dumbo University of Business and Integrated Development Studies
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Post Office Box WA64
Wa, Upper West Region
Ghana

September 16 2022

TO WHOM IT MAY CONCERN

Confirmation of language and technical editing of Naslynne Dlamianian Perseverance Andreas' master's thesis

This letter confirms that I, Professor Maurice Oscar Dassah, edited the above student's master's thesis entitled 'A skills development strategy for a selected technology company in the Northern Cape', presented to the Cape Peninsula University of Technology, Cape Town. I read the thesis thoroughly and provided feedback, included recommendations on language and style, and technical issues for rectification to improve its scholarly quality.

With respect to language and style, I pointed out problematic aspects of language in to scholarly writing such as sentences with unclear meanings, incomplete sentences, American English spellings in a supposedly British Standard English text.

On the technical side, I found a few anomalies in the Harvard system of bibliographic referencing, Table of Contents and Tables. Specifically, I identified about two in-text citations not reflected in References and a source in References not cited in the text. Additionally, incomplete acknowledgements and a few not in conformity with the Harvard system of bibliographic referencing were identified. In general, the thesis is well-written and of a level compatible with a master's degree.

In line with my mandate to edit and improve the quality of the thesis, I did not, in any way change or attempt to change the substance of the thesis, except recommend changes to enhance its clarity. Should there be a need to verify the authenticity of this letter, please contact me by email: dassabie@yahoo.co.uk.

Yours sincerely



Prof Maurice Oscar Dassah