

**The development of a competency-profile and  
implementation plan for  
Robolab operators in a selected cement factory**

**A.Manganye**

 [orcid.org/0000-0002-9270-1167](https://orcid.org/0000-0002-9270-1167)

Mini-dissertation accepted in partial fulfilment of the  
requirements for the degree *Master of Business  
Administration* at the North-West University

Supervisor: Prof Y du Plessis

Graduation ceremony: April 2020

Student number: 26870940

## DECLARATION

I, Annah Manganye, hereby declare that this mini-dissertation, submitted in partial fulfilment of the requirements for the degree Master of Business Administration in the faculty of Economics and Management Science at the North-West University, is my own original work and has not been submitted to any institution of Higher Education. All the sources used for this study are cited and referenced in the reference list.



22/11/2019.

.....  
Annah Manganye

Student number: 26870940

## DEDICATION

This study is dedicated to my mom (Emery Chiya Manganye) and my dad (Shadreck Johannes Manganye). In my early years as a young girl, my mom made me promise her that if, at any point, I get tired of studying, I can rest for myself and start studying for her and my dad.

*“Mom and Dad, this one is for you.”*

*Manganye, Mandlazi, Magoda, Siyabalonga.*

*Love you lots.*

# ACKNOWLEDGEMENTS

The favour of the Lord is upon me. My deepest gratitude to Almighty God for the gift of life, for His endless mercies and highest favour upon my life.

Several people have contributed massively to this study. If it were not for their support, encouragement and contribution, this study would not have been possible.

I would like to express my extreme sincere gratitude to the following individuals:

- Mark Hechter: Operations Manager at Sephaku Cement. Mark believed in me and gave me the support to complete my MBA. He continued to remind me how it would feel the day I have my qualifications in my hands.
- Essie Esterhuizen: Plant Manager at Sephaku Cement, who supported me throughout my study.
- My employer: Dangonte Cement South Africa t/a Sephaku Cement, for awarding me financial study assistance to pursue my MBA.
- Professor Yvonne du Plessis: My supervisor, who supported me and imparted on me more research knowledge throughout my study.
- All the participants I have interviewed, for their contribution to this study,
- My mom and Dad: Mr and Mrs Manganye, for always believing in me, for instilling education in me, even though they were deprived due to family and economic circumstances.
- My siblings: Matthews Manganye, Susan Manganye, Johannes Manganye and Martha Manganye, who were always willing to rearrange family functions and gatherings to accommodate my scarce availability. They gave me encouragement and support throughout my study.
- My wonderful life partner: Enock Tlhobogang Ncube, who became my cheerleader, my pillar of strength, encouraged and supported me throughout my study. He selflessly took over a lot of our household responsibilities, just so I could focus on my study.
- My wonderful, much appreciated three sons: Rendani, Phathutshedzo and Khuliso. They were at times deprived of Mommy's quality time, not seeing Mommy before bedtime, and holidays were put on hold due to Mommy's studying. Throughout, they understood and not even once complained about it.

## ABSTRACT

The cement manufacturing industry is prominent in the North West province of South Africa. An automated Robolab system was implemented in one of the cement factories without a competency profile for the Robolab operators and therefore could not become operational. The primary objective of this study was to identify the required Robolab operator competencies and to develop a competency profile in order to select and appoint suitable operators to commission the Robolab system in the selected cement factory. A review of the literature provided little knowledge of competency profiling of Robolab operators, but did provide the principles and practices of competency profiling in order to assist in conceptualising competency profiling for operator development for a Robolab system in a cement factory.

This study adopted a qualitative research approach with a case study design, as the research problem existed in a real-life context. Data on Robolab operator competencies were collected from participants in industries that had Robolab systems, through open-ended and semi-structured interviews. Thematic analysis was employed as a method of data analysis. A Robolab competency profile and implementation plan for Robolab operators in the cement industry was developed. The competency profile comprised four main competency areas: 1. Technical; 2. Behavioural; 3. Professional; 4. Innovation and 5. Creativity. Recommendations were outlined and managerial implications were highlighted to assist in operationalising the Robolab system.

**Keywords:** Competency profile, Robolab system, cement production factory, competence, skills, Robolab operators.

# TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENTS	iii
ABSTRACT	iv
List of Figures	vii
List of Tables	viii
List of Abbreviations and Acronyms	x
CHAPTER 1. OVERVIEW OF THE STUDY	1
1.1 Introduction to the Study	1
1.2 Motivation for the Study	2
1.3 Background to the Case Study	2
1.4 Problem Statement	6
1.5 Objective of the Study	6
1.6 Research Questions	7
1.7 Significance of the Study	7
1.8 Scope	8
1.9 Assumptions of the Study	8
1.10 Delimitation of the Study	9
1.11 Research Methodology	9
1.12 Research Ethics	9
1.13 Definition of Key Terms	10
1.14 Structure of the Study	11
1.15 Chapter Summary	11
CHAPTER 2. LITERATURE REVIEW	13
2.1 Introduction	13
2.2 Defining Competency Profiling and Its Concepts	14
2.3 Conceptual Dimension of Competency	15
2.4 Organisational Competency Profile Development	17
2.5 Competency Profiling in Automated factories	21
2.6 Research Gap in the Literature	23

2.7	Conceptualising Competency Profiling Towards Professionalism of the Robolab in Cement Factories	25
2.8	Chapter Summary	27
CHAPTER 3. RESEARCH METHODOLOGY		28
3.1	Introduction	28
3.2	Research Approach	30
3.3	Research Design	32
3.4	Population and Sampling Method	35
3.5	Data Collection Methods	38
3.6	Method of Data Analysis	43
3.7	Trustworthiness	45
3.8	Research Ethics	47
3.9	Chapter Summary	48
CHAPTER 4. DATA ANALYSIS AND PRESENTATION OF RESULT AND FINDINGS		49
4.1	Introduction	49
4.2	Presentation of Results	49
4.3	Presentation of Transcribed Results	52
4.4	Presentation of Findings: Themes and Categories	59
4.5	Discussion of Findings	79
4.6	Contribution of the Study	87
4.7	Chapter Summary	89
CHAPTER 5. CONCLUSION, RECOMMENDATIONS AND SUMMARY		91
5.1	Introduction	91
5.2	Conclusion on the Key Findings	91
5.3	Managerial Recommendations	92
5.4	Key Managerial Implications	92
5.5	Limitations of the Study	93
5.6	Suggestion for Future Studies	93
5.7	Summary	94
REFERENCES		96
ADDENDUMS		112

# List of Figures

- Figure 1.1 Cement Production Process .....3
- Figure 1.2 Quality Laboratory Organogram .....5
- Figure 2.1. Iceberg Analogy of Competency Profiling.....22
- Figure 2.2 Gap in the Literature with Regard to Competency Profiling and Robolab Organisational Structure .....24
- Figure 2.3 Conceptual Framework of Robolab Competency Profiling in a Cement Factory .....26
- Figure 3.1 Research Methodology and Processes .....29
- Figure 3.2 Example of an invitation email sent to participants .....41
- Figure 4.1 Required behavioural competencies for a Robolab operator.....60
- Figure 4.2 Technical competencies required by Robolab operators.....62
- Figure 4.3 Required educational qualifications of a Robolab operator .....64
- Figure 4.4 Required Robolab operation job experience .....65
- Figure 4.5 Day-to-day duties of a Robolab operator.....67
- Figure 4.6 Work challenges for a Robolab operator .....69
- Figure 4.7 Operational challenges of a Robolab.....71
- Figure 4.8 Availability of Training for Robolab Operators .....73
- Figure 4.9 Robolab challenges for company .....74
- Figure 4.10 Benefits of having a fully operational Robolab system .....76
- Figure 4.11 Way Forward for an Effective Robolab System .....78

# List of Tables

- Table 2.1 Concepts and Dimension of Competency ..... 16
- Table 3.1: Outline of Research Methods per Research Question .....30
- Table 3.2 Strengths and Weakness of Semi-Structured Interview .....40
- Table 3.3 Interview schedule.....41
- Table 4.1 Pseudonyms of the participants .....50
- Table 4.2 Years of Work Experience .....51
- Table 4.3 Educational Qualifications .....51
- Table 4.4 Nationality.....52
- Table 4.5 Purpose of the Robolab operator .....53
- Table 4.6 Duties of the Robolab operator.....53
- Table 4.7 Job experience for the Robolab operators.....54
- Table 4.8 Required educational qualifications .....55
- Table 4.9 Required technical competencies.....55
- Table 4.10 Required behavioural competencies .....56
- Table 4.11 Work challenges faced by Robolab operators .....56
- Table 4.12 Robolab challenges faced by companies .....57
- Table 4.13 Robolab skill availability.....57
- Table 4.14 Availability of training.....57
- Table 4.15 Reasons why companies acquire the Robolab system .....58
- Table 4.16 Operational challenges with the system .....58
- Table 4.17 Recommendations for an effective Robolab system .....59
- Table 4.18 Quotes re behavioural competencies .....61
- Table 4.19 Quotes re technical competencies for a Robolab operator.....63

Table 4.20	Quotes re educational qualification.....	65
Table 4.21	Quotes re operation job experience .....	66
Table 4.22	Quotes re day-to-day duties .....	68
Table 4.23	Quotes regarding work challenges .....	70
Table 4.24	Quotes re operational challenges.....	72
Table 4.25	Quotes regarding availability of training.....	73
Table 4.26	Quotes re challenges for the company .....	75
Table 4.27	Quotes re benefits of a fully operational system.....	77
Table 4.28	Quotes re way forward .....	79
Table 4.29	Responses to the main research question .....	80
Table 4.30	Responses to research sub-question 2 .....	84
Table 4.31	Integrated Robolab Competency Profiling Model .....	88

## List of Abbreviations and Acronyms

HRM	Human Resource management
IoT	Internet of Things
ETA	Employment and training Administration
DOL	US Department of labour
RO1-RO13	Pseudonyms for all the participants contributed to this study
ROS	Robot operating System
IT	Information Technology
KSAOs	Knowledge, skills, abilities, and other characteristics
LIMS	Laboratory information Management System
OEM	Original Equipment Manufacture
QA	Quality assurance
XRF	X-Ray fluorescence

# CHAPTER 1.

## OVERVIEW OF THE STUDY

### 1.1 Introduction to the Study

It is common knowledge that employees are the most valuable resources a company has to ensure that organisational performance is maintained and success is realised. In order for employees to perform their best, they have to be competent. A structured competency profile is important to ensure a company attracts people with the right talents and competence structure to optimise their productivity.

This chapter provides the background to the study, the motivation for it, the problem statement, specifies the objectives of the study and its research questions, and explains its significance.

In today's knowledge-orientated world, most organisations have prioritised the identification, retention and attraction of talented employees in order to attain their organisational goals (Vaiman *et al.*, 2012:926). For an organisation to achieve its goals, a certain standard of competence is expected of employees. Organisational competency profiles have been found to enhance the sustainability of optimal productivity (Liu *et al.*, 2016). In times of globalisation and dynamic technological change, the strategic management of competence at all staff levels is a key performance indicator for human resource management (Liu *et al.*, 2016; Srividya & Basu, 2015).

As such, today's organisations are all talking about competencies: Gone are the days when organisations used to talk about skill sets that would make their organisations competitive. Organisational focus has therefore shifted from planning to survive competition to sustainable, excelling productivity (Baral & Pokharel, 2017; Duran & Mancha-Navarro, 2018). Production houses that use automated systems, as a driver of artificial intelligence, are among many organisations that are currently facing socio-technological changes, and are expected to employ a competency profile that will positively influence organisational value creation among employees. Automated factories, as contemporary organisations, are faced with the challenging task of obtaining the right talent in the midst of a competition for talent, in the face of a skills shortage and employee mobility (Jin, 2018). Therefore, the continuous advancement

of automation in the organisation makes competency profiling a fundamental task that must be performed if production sustainability is to be maintained.

This study seeks to develop a competency profile for Robolab operators in cement factories in South Africa in order to ensure that a talent development plan is in place for the Robolab operators in a selected cement factory, to optimise productivity and organisational goals.

## **1.2 Motivation for the Study**

The recent industrial revolution has made companies move from a commodity-based economy to a knowledge-based economy (Nilson & Ellström, 2012; Yigitcanlar & Bulu, 2015). Organisations are driven to look for employees who can handle the complex nature of the work, organisational structural changes and the growing importance of sustaining relationships (Thinnisses *et al.*, 2013). In essence, successful organisations are the ones that constantly acquire new knowledge, diffuse it throughout the whole organisation, and incorporate new technology for optimal productivity (Whelan *et al.*, 2010).

In the field of automation professionals, there is also a general shortage of skilled operational personnel, which cannot be overlooked as it affects the general output of an organisation (Gavin, 2012). Thus, a properly implemented competency profile in an organisation that has automated system, has the additional advantage of providing guidelines for operational skills and flexible structures. Hence, the motivation for this study is to examine the competency profile and implementation plans for Robolab operators in a South African cement factory. It will also be expected that the findings of this study will assist in integrating and reconciling the most uncertainties surrounding the operational inconsistencies within the Robolab system operation currently experienced in a South African cement factory.

## **1.3 Background to the Case Study**

Most manufacturing companies have recently been upgrading with high technology mechanisms to boost their productivity (Ebrahimi *et al.*, 2008). Cement factories are not excluded from this because the production channel passes through a process that involves techniques and competency. Hence, the focus of this study is on competency

profiling in a selected cement factory in South Africa. According to (CNBC Africa, 2014) and Global Cement news (2014), this cement factory in the North West Province was the first to be built since 1934 and the aim was to implement the latest technology to produce more clinker and cement. The target was for its two plants, one in Mpumalanga and one in North West, to produce up to 1.4 million tons of cement per year altogether.

Previous research has shown that the demand for cement, in South Africa and all over the world, is growing and will continue to grow (Shafeek, 2014; Rosenthal, 2007:2). According to Heyns (2013) and Uzzaman *et al.* (2016), the demand for cement is influenced by the growth of the middle-class population. As the population increases, there is an increased demand for the basic needs of survival, such as housing, and cement is the major ingredient in the building materials. In order to meet this demand, more sophisticated equipment has been incorporated into the production system, with which operators are required to familiarise themselves. The process of cement production demands highly competent operators to reduce operational inconsistency and non-conformance, as illustrated in Figure 1.1.

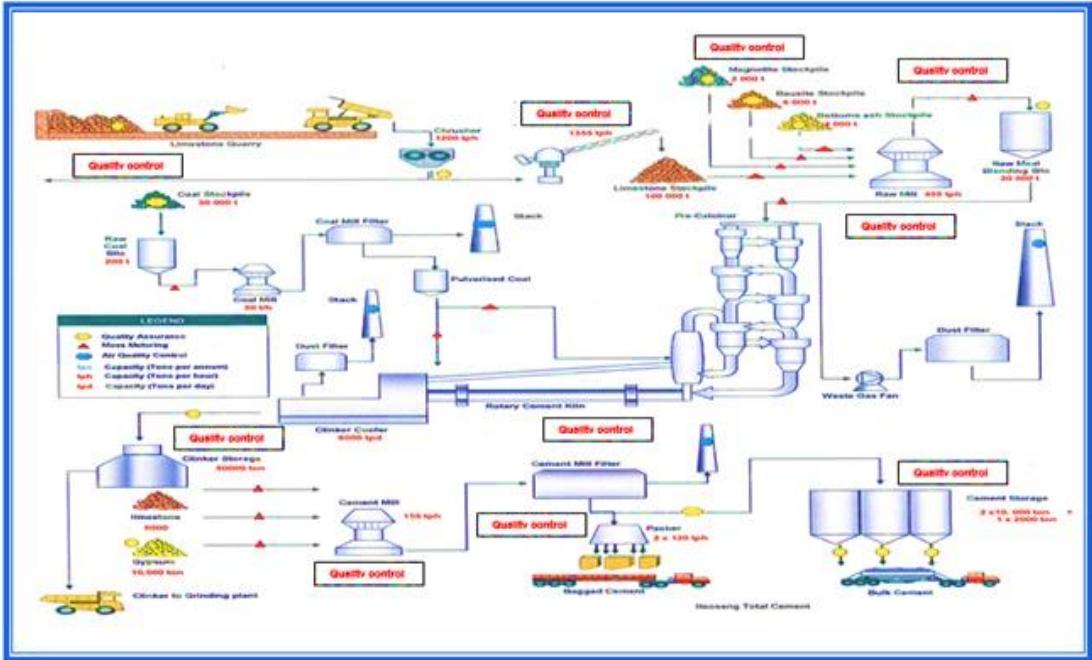


Figure 1.1 Cement Production Process (Adapted from Greatwall Corporation, 2019)

Figure 1.1 is a flow diagram of cement production, which shows that, at every strategic point, quality must be monitored to ensure that cement of high quality is produced. In cement production, it is important that quality testing is carried out timeously as per the quality plan to ensure that corrective measures are taken as quickly as possible and that any quality deviations are corrected in time.

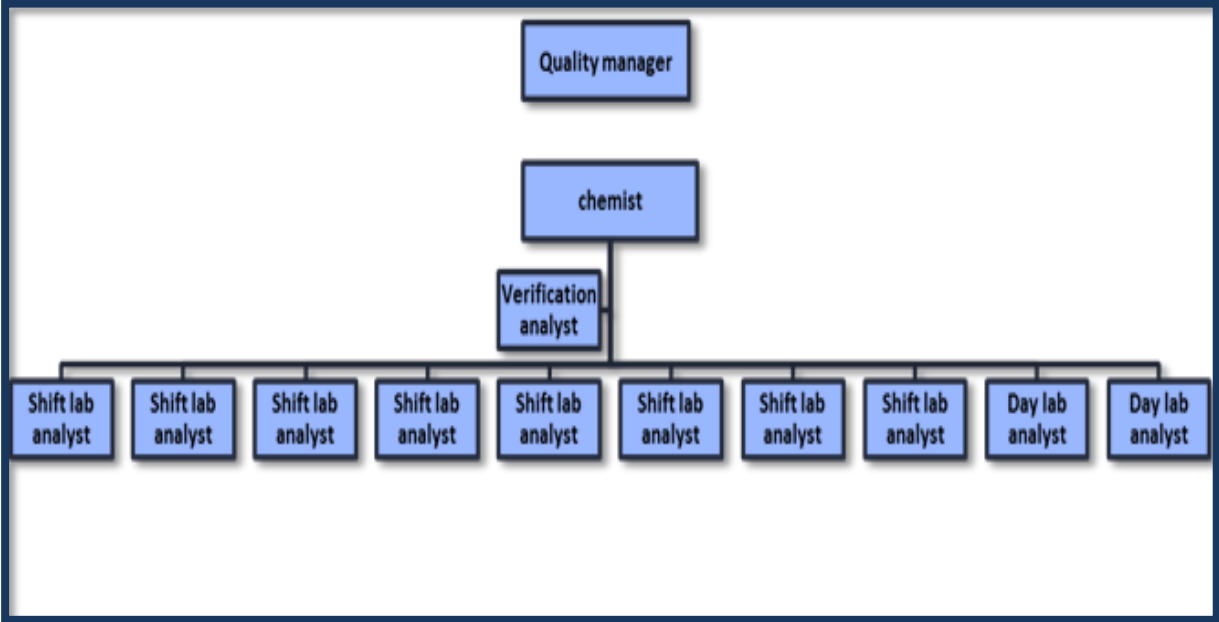
The new cement factory aimed at counteracting the cement shortage, so its goal was to use new and more sophisticated equipment to increase cement production by 2.6 million tons (Heyns, 2013). In order for the factory to meet the expected production increase, it was decided to employ automated systems wherever possible.

Robolab technology was introduced into the cement factory to make quality control as efficient as possible, thus minimise quality non-conformances during cement production. Due to the importance of accurate analytical results for quality cement production, competence in each of the operational functions is imperative. In essence, if the requisite competence is available, use of Robolab automation has tremendous benefits, ranging from the elimination of sample errors to the elimination of operational errors (FLSmidth, 2016). It is therefore paramount that a competency profile for professionals who can manage and operate the Robolab is available and properly implemented (Harrisson, 2019; Karabegović *et al.*, 2015).

Automated systems come with their own challenges. An organisation that requires an automated system needs to be aware of these challenges in order to resolve or mitigate them (Christofides *et al.*, 2007:2737). The cement factory referred to in this study was not spared these operational challenges. Little was known about the competencies needed by the candidate who would be operating it, the skill needed to maintain and service it, and the cost of maintaining it. The laboratory analysts who were employed did not have the skills needed to operate and troubleshoot the automated system. The engineering and IT department team were not conversant with the operation of the Robolab system, as the system was of high technology, which was new to them and no training was given.

Figure 1.2 illustrates the proposed organogram of the quality assurance department that would be responsible for the operation and management of Robolab. The structure was such that the laboratory analysts with laboratory knowledge would operate the Robolab system. It made provision for two laboratory analysts per shift, on a two-shift

cycle. One laboratory analyst was to focus on operating the Robolab and the other to perform manual testing in the chemical laboratory.



**Figure 1.2 Quality Laboratory Organogram (Adapted from quality assurance department in the cement factory, 2014)**The cement factory had a competency profile for a laboratory analyst but it did not cover competencies for operating the Robolab, and the system also did not come with any competency profile for the operators.

Competency management focuses on providing the skills, knowledge and attributes necessary for employees within an organisation in an effort to maximise productivity (Gitelman *et al.*, 2018; Rondon & Fontes, 2017). Although the service provider did supply a few days of training for a laboratory analyst, the training was not adequate. The training revealed that the laboratory analysts in the cement factory did not have the right competencies for the efficient operation of the automated Robolab system. The laboratory analysts did not have basic computer skills, whereas the Robolab system required advanced technology capabilities. The operator has to understand the different commands in the software and troubleshoot the numerous error messages in the equipment. The operator must be able to deduce the logic of the error messages and be able to clear them.

Competency profiling is intended to integrate several related administrative activities into a logical process. Like most management systems, it involves knowledge

management, designing, planning, implementing, monitoring and reviewing. Competency profiling has been found to play a pivotal role in the ongoing sustainability of organisational goals in a world that is changing in ways that require potential employees to have a range of core skills and job-specific skills (Simic & Nedelko, 2019). Competency profiling and implementation therefore not only enhance the sustainability of organisational goals, but also help incorporate other management systems to arrive at a logical output that meets the present market demands.

#### **1.4 Problem Statement**

Several studies, such as those of Kopacek (2018); Simic and Nedelko (2019); and Vladova *et al.* (2017), have identified competency profiles as a crucial factor in enhancing the sustainability of organisational productivity. However, they tended to focus more on the importance of competency profiling in a holistic organisational structure than on ascertaining what constitutes a logical competency profile and what implementation process is suitable for the operational process of automated laboratories such as the Robolab systems.

Robolab is a section of an automation laboratory that can be used in a cement production factory for faster turnaround time on production sample results, and it requires core competency and operational specification skills for logical and optimal productivity (Harrisson, 2019). The service provider did not supply a competency profile for Robolab operators. This lack of a specific competency profile and implementation plan had repercussions for the quality assurance department responsible for operating the Robolab system in a cement production factory. Hence, a study was needed to compile a competency profile and an implementation plan that would enhance the professional operation of the Robolab, which was currently dormant. To do this, the researcher looked to other organisations, in South Africa and in other countries, for a competency profile suitable for the Robolab operators.

#### **1.5 Objective of the Study**

The objective of this study was to describe the required Robolab operator competencies and to develop a competency profile in order to select and appoint suitable operators to commission the Robolab system in a selected cement factory.

## **1.6 Research Questions**

The main research question of this study was: What are the requisite competencies, to be included in a competency profile that will enhance the professional performance of Robolab operators in a cement production factory?

The research study sought to clarify the following sub-questions:

- What are the requisite technical and behavioural competencies that other companies are using in South Africa and in other countries in similar operations?
- What are the competency gaps and challenges that exist in the Robolab system in the cement factory under study?
- What are the benefits of and recommendations for the effective operation of the Robolab system?

## **1.7 Significance of the Study**

The Robolab technology was introduced into the cement factory to improve the production of high-quality cement and to change the old ways of doing things by using advanced technology. This was expected to help eliminate the sampling errors that come with manual sampling and sample preparation. The Robolab is an assembly of high-tech machines, and a core competency profile is needed for its professional operation. The significance and benefits of this study therefore include, but are not limited to, the following:

- Guidelines for implementing better talent management within the Robolab section of the cement factory and adhering to a professional competency profile.
- This study promulgated the importance of competency profiling for users of the Robolab system in cement production.
- The findings in this study could be used to improve the existing competency profile of the cement factory.
- This study will improve Robolab operators' awareness of the importance of developing competency in their work stations.
- This study will help to improve health and safety in the factory and produced business benefits.

- This study will contribute to the body of academic work by improving understanding of the role of competency profiles for related automated systems in the cement factories.

### **1.8 Scope**

Even though the company has two identical automated laboratories in two different locations and departments, this study was conducted only in the quality assurance department of the cement factory in North West province. The Robolab in the other location is also not fully operational, but the reasons for non-operation are different from those at the North West location.

The literature review on this study will not address different strategies of developing competency profiles or competency models. Since the aim of this study is to develop a competency profile for the Robolab operators, the current laboratory staff in the quality assurance department were included in the study to determine the current competencies and to analyse the gap between the current competency available and the competencies that should be developed for a potential Robolab operator. The quality assurance manager, the Robolab service provider locally and in India, were included in the study. The Robolab system is a specialised technology that in the cement production factories, only the experts from the service provider and other similar mineral companies were used to develop the competency profile. Even though the study involved different personnel within the company and service provider, permission was asked before participation took place.

### **1.9 Assumptions of the Study**

The following were the assumptions for this study:

- that the company would give the necessary support;
- that the service provider, local and international, would be willing to participate in the study;
- that those who had the competencies would share them;
- that the Robolab was not operational only because of the lack of competency, even though it had been standing unused for a long time; and
- that the current laboratory staff would be trainable.

### **1.10 Delimitation of the Study**

This study focused on competency profiling within automated factories, with specific reference to Robolab in the cement industry. The researcher carried out a literature review of the studies that addressed the topic both internationally and within South Africa. The empirical part of the study focused on the operators of Robolab systems and the competencies needed to be able to operate them efficiently and effectively.

### **1.11 Research Methodology**

According to Benoot *et al.* (2016:21) and Bresler and Stake (2017:115) there are three major approaches in research: quantitative, qualitative and mixed-method (quantitative and qualitative). This study adopted a qualitative approach with an exploratory case study design as the study focused on a real-life problem in a context where little knowledge was readily available (Leitner & Strauss, 2008:5). An exploratory case study research design includes an up-close, in-depth and detailed examination of the phenomenon under study (the case of the Robolab and its operators) and its related contextual conditions (Zainal, 2007).

This study adopted a purposive and convenient (non-probability) sampling method (Creswell, 2017) with a targeted population of companies that were using the Robolab system within their operations. These were Robolab managers and operators in cement factories in South Africa, Denmark, India and Germany, as well as the technical representatives from the Robolab manufacturers. Companies from other sectors, such as the mining sector, who had similar systems, and related service providers in other industries were also included. This study collected data from willing participants who had the knowledge and experience of using a Robolab system within their organisations, through interviews with open-ended and semi-structured questions. Thematic analysis was employed using the ATLAS-ti as an analysis instrument to identify the requisite competencies as themes in the data collected.

### **1.12 Research Ethics**

Ethics in research is the standard in a research process to protect the participants in the study, to develop their trust, to uphold the integrity of the research, and to guard against misconduct in the process of data collection (Creswell, 2014:132). Ethical

approval was therefore obtained for the study from the Ethics Committee of the North-West University (Addendum A) before embarking on data collection. Permission for conducting the research was obtained from the Company (Addendum B) and participants were asked for their consent before they were interviewed. The procedure and what was expected of participants were explained, as well as the questions to be answered.

### 1.13 Definition of Key Terms

**Competence.** According to Moore *et al.* (2002), *competence* is the ability and willingness to perform a task. Other authors defined competence as “being a number of possibilities, such as generic knowledge, and the motives, traits, social roles or skills of a person”.

**Competency Profiling.** Competency profiling is a set of organisational standards that combine the skills, knowledge, abilities and other characteristics required by employees to perform their job effectively (Shellabear, 2002:16).

**Robolab.** A fully automated laboratory solution, machined by a robot and the operator, who gives the mechanism commands (FLSmith, 2016).

**Competencies.** Moore *et al.* (2002) emphasised that the word *competencies* reflects the recognition of the level of professional competence deriving from the possession of a number of releasing attributes, such as knowledge, skills and attitudes.

**Clinker.** It is burnt rock, produced by burning limestone with other additives to produce cement.

**Limestone.** A hard sedimentary rock, composed mainly of calcium carbonate, used as building material and in the making of cement.

**Fused bead.** A powder mixed with glassy material, such as flux, and heated at high temperature to create a fused bead. The fused bead is analysed by the XRF machine.

**Pressed pellet.** A powder pressed in a ring or cup, using a set of dies and a pressed pellet machine. The pressed pellet is then used to analyse its elements by using an XRF machine.

**XRF.** Analytical equipment that uses X-rays to determine the elemental composition of a sample.

**LIMS.** Laboratory information management system: It is a data management system for laboratories.

#### **1.14 Structure of the Study**

**Chapter 1:** Overview of the Study. The chapter introduces the motivation for and background to the study, the problem statement and the objectives of the study. The research questions and significance of the study are discussed, as well as the research methodology.

**Chapter 2:** Literature Review. This chapter presents a review of the theoretical foundation of the study. It focuses on competency profiling, the conceptual dimensions of competency, organisational competency profile management, and competency development.

**Chapter 3:** Research Methodology. This chapter focuses on the methods and procedures used to actualise the objectives of the study. These procedures included but were not limited to the research design, research method, sampling method and the target population of the study. The chapter also discusses the research instruments used to obtain data and the treatment of the data. Limitations and ethical issues that arose in the data analysis are highlighted.

**Chapter 4:** Data Analysis and Presentation of Results and Findings. The chapter reports the analysis of the qualitative data and presents results. It provides descriptive and content data analysis, followed by a detailed interpretation and presentation of results and findings. The contributions of this study were informed by these results.

**Chapter 5:** Conclusion and Recommendations. This chapter summarises the entire study and makes suggestions for future research.

#### **1.15 Chapter Summary**

This chapter provided an introduction and background to the necessity for developing a competency profile for Robolab operators in the cement industry.

The next chapter reviews previous literature on competency development, different competency models, competency development, competency profiling, and implementation planning in an organisation.

## **CHAPTER 2.**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The main objective of a literature review is to obtain information that has already been studied and published by other academics to gain more knowledge about the study. This provides a broader picture and better understanding of the research problem, its goal and its importance for research. The review of literature focused on global initiatives on competency profiling and talent management, as well as competency models in organisations and automation departments. This helped in identifying gaps in the literature, as well as offering guidelines for the implementation of competency profiles of the Robolab system in cement factories, especially in South Africa.

The Robolab in the quality assurance department consisted of high-tech equipment and a robotic arm controlled with IT software. The operator of this Robolab needs to possess and maintain a specific level of competence to operate the system and to be able to troubleshoot and clear errors as they occur. It has been observed that the most successful high-tech factories are the ones that always seek to acquire new knowledge, be it new technology, new products or new ways of doing things, and ensuring that all of the company's employees are kept competent (Amrina & Vilsu, 2015; Scrivener *et al.*, 2016). Indeed, many companies have come to understand that their success depends on the performance of their employees, as the development of employees with up-to-date operational technology enhances optimal production sustainability (Amrina & Vilsu, 2015; Van Vuuren *et al.*, 2018).

Workplace professionalism has definitely changed. The focus has moved to knowledge-based commodities, with jobs being more complex, unpredictable and insecure (Scrivener *et al.*, 2016; Thunnissen *et al.*, 2013). It is very evident that, over the years, the number of less-skilled jobs is decreasing, while the most skilled, complex, knowledge-based jobs are increasing in number (Yuvaraj, 2011). Thunnissen *et al.* (2013) are of the view that organisations are focusing on recruiting employees who can perform complex work as organisational structure changes all the time and they have realised that it is important to maintain sustaining relationships. For this reason, there is more focus on human resource management, which is defined as the

process of bringing people and the organisation together so that the goals of each are met (Noe *et al.*, 2017; Yuvaraj, 2011:1). Employees have been identified as the most valuable resources in an organisation, and that the way they are used gives a competitive advantage to the organisation. Employees must therefore know the norms and values of their organisations (Noe *et al.*, 2017; Vakola *et al.*, 2007).

According to Vakola *et al.* (2007), many organisations are focusing on the best ways to select and develop effectively performing employees. It is therefore important that the organisation has people with the right competencies to help it realise its strategic goal, and these competencies need to be identified, defined, developed and measured (Amrina & Vilsu, 2015; Van Vuuren *et al.*, 2018). In the recent competitive world, there is high demand for productivity, increased flexibility and lower production costs, which results in organisations' seeking to employ only people who have the right competencies and who are ready to put those competencies into operational practice (Arunkumar *et al.*, 2019; Garavan & McGuire, 2001).

## **2.2 Defining Competency Profiling and Its Concepts**

In determining the meaning of competency profiling, it is important to define competency first, as it has been given many, sometimes conflicting, meanings (Shippmann *et al.*, 2000). McClelland (1973:9) delivered the first definition of competency, defining it as "a personal trait or set of attitudes that leads to more efficient or superior job performance". Gervais (2016) says very simply that "it is something that describes how a job might be done excellently. Although competency does not define how the job can be done, it outlines the intellectual, managerial, social, and emotional competence of an employee. Shippmann *et al.* (2000:706) defines competency as "A mixture of knowledge, skills, abilities, motivation, beliefs, values and interest". Similarly, Kock and Weeks (2015) and Vakola *et al.* (2007) define job-related skills as the underlying set of employee's behavioural patterns, which are related to effective and superior work performance, both individually and collectively, and provide a sustainable competitive advantage to the organisation in which they are implemented and applied.

For the purpose of this study, competency is defined as the ability to apply a set of relevant expertise, skills and abilities needed to perform critical work functions successfully in a defined work environment. Given this definition of competency, a

competency profile is a document capturing and identifying the competencies for a given work function. Janani and Gomathi (2015) and Prikshat *et al.* (2018) define competency profiling as a set of organisational operation guideline, standards and values that enhance excellent performance in a particular job context. It therefore involves the process of identifying, defining and measuring those skills believed to enhance higher employee job performance in a particular workplace within the context of professionalism.

The purpose of competency profiling is to identify the skills, knowledge and ability required to perform and organise the job, role, shared function or occupation in an easily accessible and useful manner. Competency profiles are the basis for the development of a comprehensive performance that spells out exactly what the employee has to do in order to perform successfully on the job (Moustroufas *et al.*, 2015; Prikshat *et al.*, 2018). Thus, the benefits of competency profiling in an organisation include but are not limited to the following:

- providing the basis for recruitment and selection;
- identifying employees' skill, strengths and gaps;
- targeting development skills and gaps;
- creating development plans for employees;
- developing training programmes that address the skills needed to succeed in organisations; and
- identifying overlapping job roles.

Although there are difficulties in actualising competency profiling in most organisations, the benefits are manifest, as it enhances the competitive advantage of an organisation. Organisations usually start the process of competency profiling by identifying the key roles within their organisations where profiles of competencies can deliver the greatest benefits.

### **2.3 Conceptual Dimension of Competency**

The key concepts in competency profiling include a combination of operational guidelines on the skills, knowledge, attitudes and abilities that enhance an employee's job performance. There are four important concepts that make up the definition of a competency. These concepts were suggested by human resource experts in a

conference on competencies held in Johannesburg, South Africa in 1995 (Mitra *et al.* 2008:11). The authors emphasise that a competency profile should :

- Include the combination of skills, knowledge and attitudes that have an influence on a major part of an individual's job;
- that it should have proven good relationships, with excellent job performance;
- that it can be measured by using accepted methods and standards; and
- that it should be able to improve through training and development.

Curnow (2015) agreed with the above concept of competency, but added that the concepts of competency include the employee's motives, traits, attitudes, values, knowledge, cognitive ability and that these characteristics can be measured to distinguish top achievers and those that are not. Table 2.1 provides a synthesis of the core concepts and dimensions of competency in the literature.

**Table 2.1 Concepts and Dimension of Competency**

<b>Authors</b>	<b>Dimensions</b>	<b>Competency Concepts</b>
Boyatzis (1982)	Efficient personal skills	The characteristics that an employee possess that enable the performance of the required job.
UK National Vocational Council for Vocational Qualification (1997)	Effective personal ability	The ability to carry out the job as per the outlined employment requirement.
Dubois (1998)	Efficient personal knowledge and skills	Knowledge, skills and mindsets that, when used by an employee, can result in successful performance.
LeBoterf (1998)	Personal ability	The ability to perform excellently in a job context.
Marrelli (1998)	Human capabilities	Human capabilities that are needed to be able to perform work effectively. These capabilities should be measurable.

<b>Authors</b>	<b>Dimensions</b>	<b>Competency Concepts</b>
Treasury Board of Canada Secretariat (1999)	Personal knowledge, skills, abilities and behaviours	Knowledge, skills, abilities and behaviours that an employee applies in performing his or her work.
Intagliata <i>et al.</i> (2000)	Employees' skills and capacity	Employee's skills and capacity to achieve organisational goals.
Perrenaud (2000)	Efficient capacity	A capacity to mobilise diverse cognitive resources to meet a certain type of situation.
Selby <i>et al.</i> (2000)	Personal ability	An ability expressed in terms of behaviour.
Jackson and Schuler (2003)	Effective personal skills, knowledge, ability and attitudes	The skills, attitude, knowledge, abilities and other characteristics that an employee would need to effectively perform a job.
Gartner Group (2019)	Personal skills, knowledge and attributes	A set of characteristics, including skills, knowledge and attributes, that enable the performance of the required job.

Source: Adapted from Draganidis and Mentzas (2006)

From Table 2.1, it is evident that most competency concepts are based on the knowledge, skills, abilities and attitudes of an employee. However, some authors perceive competency as a behavioural expression that leads to excellent job performance. The concept of competency was referred to by Moore *et al.* (2002:315) and Shippmann *et al.* (2000) as a combination of knowledge, skills, abilities and other individual characteristics (often called KSAOs, which include but are not limited to motives, personality traits, self-concepts, attitudes, beliefs, values and interests) that can be reliably measured and shown to differentiate individual job performance.

## **2.4 Organisational Competency Profile Development**

The process of developing a competency profile in an organisation begins with identifying and defining organisational goals and objectives. The clarification of

organisational goals and objectives provides a clear vision of what the organisation expects to achieve in a specified period with the initiative of the organisational competency profile (Podmetina *et al.*, 2018; Vlok, 2017). An organisational competency profile supports the organisational goals concerning change management, boosting retention and developing learning resources (Shah, 2016; Vlok, 2017). Hence, every competency architecture is uniquely designed based on the organisational goals and the internal structure. It provides a common set of rules to ensure job profiles are consistent, easily communicated and effectively implemented.

Most scholars perceive competency profile development within an organisation as a link between organisational objectives and employee performance (Podmetina *et al.*, 2018). The integration of organisational objectives and employee performance is difficult for an organisation to achieve with the recent market demands. Ascertaining organisational values is a major focus in developing organisational competency profile, as it influences talent improvement, saves costs and improves organisational performance (Shah, 2016; Shet *et al.*, 2017). No doubt that the definition of competency addresses the desired personal attributes, behaviours, knowledge and skill that enable a person to handle the requirements of the job (Basmawi & Usop, 2016; Hancock *et al.*, 2019).

Although there are different approaches to developing organisational competency profiles, the most common are at the individual job level or the organisation level (Podmetina *et al.*, 2018). Sengupta *et al.* (2013) detailed the stages involved in organisational competency profile development as follows:

- a. conducting background and research about the competencies;
- b. Identification of competencies;
- c. competency assessment;
- d. documenting and reporting the results of the process.

Although, in most cases, technical and operational skills are not readily available, training should be conducted to develop the overall underlying competencies to suit the required skills needed in that organisation. Hence, the developmental aspect of competency profiling through competency literacy becomes necessary to ascertain the operator's underlying attributes and integrate them with the organisational standards. The competency model presented by Boyatzis (1982:10-39) shows that, to attain a

specific competency standard in an organisation, three major demands must be considered: the employee's competencies, the competencies demanded by the task, and the organisational environment. Addressing these will help ascertain the vital attributes of key positions within the organisation (Shet *et al.*, 2017; Shah, 2016).

Similarly, Draganidis and Mentzas (2006) emphasised that organisational competency profile development is the process of scheduling activities to upgrade the proficiency levels of the competencies among employees. Hence, the expected result of developing a competency profile in an organisation is for excellent job performance from employees, which helps to meet organisational goals.

The developmental chain for an organisational competency profile identifies the stages involved in the growth of the competency profile within the organisation. The chain begins with the clarification of organisational goals, values and standards. This stage gives a breakdown of the vision and expectations of an organisation. The second stage focuses on identification of technical and operational skills needed for the organisation to achieve its goals. When the needed organisational skills have been identified, competency literacy education should be adopted to develop and improve employees' knowledge (Henriksen *et al.*, 2016; Ungerer, 2016). However, employees' abilities and attitudes should be measured to ascertain the level of efficiency of their technical and operational skills, which, at the efficient level, informs excellent job performance (Sailer *et al.*, 2017). The developmental chain for an organisational competency profile provides the mechanism for the organisation to achieve its goals and maintain its values and standards.

#### **2.4.1 Organisational Competency Profile Management**

Organisational competency profile management may sometimes be confused with organisational competency profile development. In essence, competency profile management is more holistic to an organisation as it comes after a competency profile has been developed. Competency profile management deals more with secondary elements within the organisational structure (Koh *et al.*, 2017; Stepanenko & Kashevnik, 2017). Accordingly, organisational competency profile management focuses on three different levels: organisational, positional and individual. The management of these levels is centred on the organisational competency profile, which is employed as a structure in different organisations (Vlok, 2017).

The aim of analysing organisational competency profile management is to simplify the behavioural, functional and multi-dimensional competency components within the organisation. Analysing the organisational management structure of a competency profile requires an understanding that an organisation's excellent performance is a function of the variables that are included in their management structure (Vladova et al., 2017). The competency profile management structure should therefore be segmented into four areas: intellectual capital management, human resource management (HRM), knowledge management, and process and performance management (Hintringer & Nemetz, 2011:288).

Intellectual capital management occupies the operational head of this structure, as the remaining departments are secondary to it. The organisational competency profile falls under human capital management, which informs HRM, knowledge management, and process and performance management. Similarly, HRM is responsible for recruitment, training, talent management and successor planning to meet the vision and goals of the organisation (Podmetina *et al.*, 2018; Vlok, 2017). According to Stepanenko and Kashevnik (2017) and Obeidat *et al.* (2015), the knowledge management department identifies knowledge needs, as well as providing the resources for the documentation of the identified knowledge. The process and performance management department formalises the whole process and ascertains future competency requirements.

The aim of the entire structure is to provide a standardised competency profile structure, which helps in meeting organisational goals, achieving organisational optimal performance, and fostering professionalism.

#### **2.4.2 Benefits of Organisational Competency Profiling**

Developing an organisational competency profile has many benefits for both the organisation and its employees (Basmawi & Usop, 2016; Connor, 2016). It provides a comprehensive basis for organisational development and performance, as detailed below:

- provides the basis for recruitment and selection;
- helps identify skills, strengths and gaps among employees;
- targets skills gaps for development;
- creates employee development plans;

- develops training programmes that address the skills needed for organisational success; and
- helps identify overlapping job roles.

## **2.5 Competency Profiling in Automated factories**

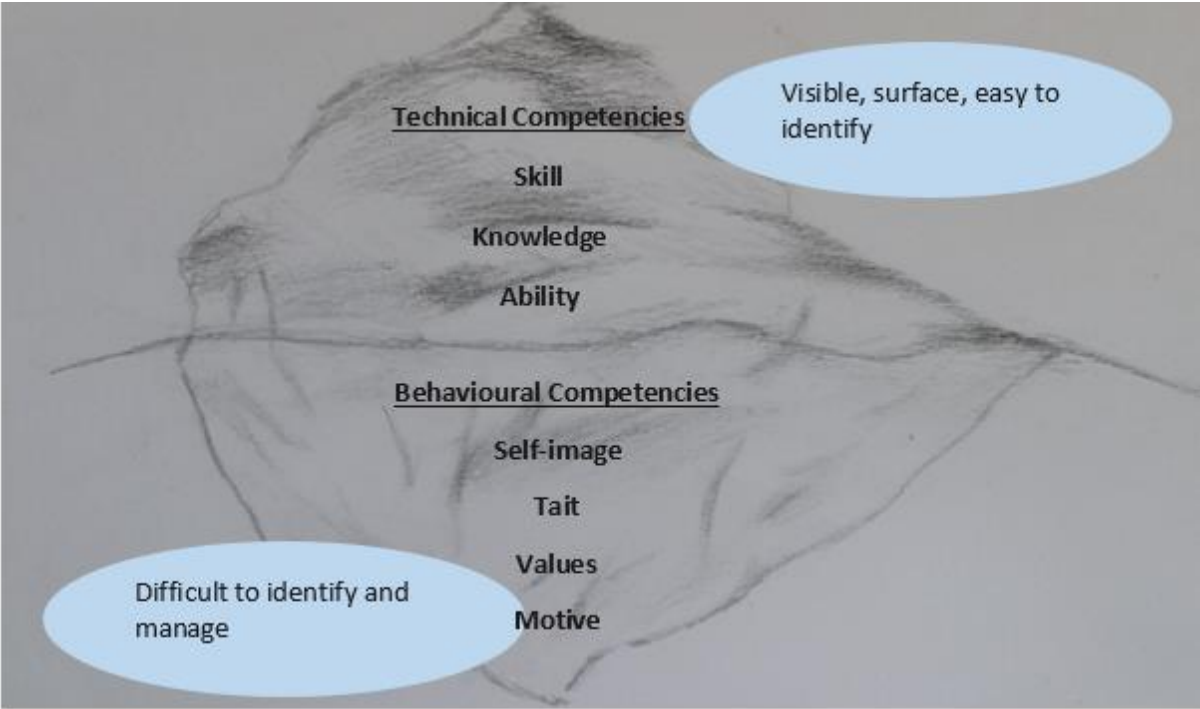
The new buzz word for today's technological era, known as the fourth industrial revolution, is "industrial 4.0". It has influenced most areas of automation in many organisations, which in turn has influenced automated job specifications. Recent technological developments including cyber-physical systems such as sensors, the Internet of Things (IoT), or smart networks and robotic machines have increased the need for competent employees in the world's automated factories, in the quest to meet the challenges the world is facing today. These include the rise of resource and energy efficiency, production, demographic changes, to mention but few. Because of these developments, in 2009, the Automation Federation, in association with the Employment and Training Administration (ETA) of the US Department of Labour (DOL), launched the Automation Competency Model (the first produced by the DOL). Leaders of the automation industry and ETA staff worked together to develop this comprehensive competency model for automation careers, to help and increase the number of those who pursue careers in this vital profession.

The Automation Competency Model clearly states the skills an employee needs to effectively perform the tasks required in automation careers. However, the process of implementing this model, which is an example of organisation competency profiling, has been identified as the lifeline that could integrate these concepts into a practical context (Longo *et al.*, 2017; Shah, 2016). Most developed nations have adopted competency profiling to identify the specific skills, knowledge, attitudes, and behaviours needed to accomplish an operational task in automated factories (Emami, 2017; Vladova *et al.*, 2017). In reality, the concept of competency profiling in automated factories is diverse, as different factories perform differently.

Moore *et al.* (2002:315) emphasised that competency profiling in an organisation takes two directions: firstly, establishing the proven ability to perform a job competently according to the organisational standard; and secondly, a set of behaviours the employee must display in order to perform the tasks and functions of the job with competence. This means competency profiling in automated factories should focus on

identifying the behavioural competency of the employee, as well as the required technical competence needed to attain excellent performance in their duties (Kassem *et al.*, 2018; Walker *et al.*, 2016). However, challenges exist in integrating and managing both behavioural and technical competency, hence the critical need for profiling in automated factories.

The iceberg analogy illustrated in Figure 2.1 demonstrates the value of looking at the overall picture of the competencies needed for excellent automated job performance: It is very easy to see the tip of the iceberg but the majority of its bulk is hidden under the water. Behavioural competency is difficult to identify and manage, and is mostly needed to enable individuals to exercise the skills they have developed to perform the job (Wayne & Simpson, 2013).



**Figure 2.1. Iceberg Analogy of Competency Profiling (Adapted from Handayani & Siswoyo, 2017; Sanghi, 2016)**

The iceberg analogy identifies two levels of competence that need to be managed to attain professionalism in automated factories. First, the technical competencies, which include skill, knowledge and ability, set by organisational standards to perform in the

job context; and second, the behavioural competencies, which includes the self-concepts, traits and motives of the employees. The technical competencies are visible and easy to manage because they are included in the standards and guidelines of an organisation (Handayani & Siswoyo, 2017; Sanghi, 2016). The behavioural competencies embedded in the behaviour of the employee are difficult to identify and manage (Mathur & Hameed, 2016). This is why competency profiling in an automation factory must integrate and manage both technical and behavioural competencies to attain organisational objectives.

Gavin (2012) emphasises that the shortage of skilled automation professionals can no longer be ignored. He adds that ignoring this will widen the gap, which will encourage outsourcing and lack of interest in the profession. It is therefore important to identify, define and develop the competencies required by automated factories. It has also been suggested that factories should begin to develop their own automation talent, relevant to their own automation needs (Gavin, 2012; Shellabear, 2002:16). Development and training should therefore not be seen as events but as a process that needs to be carefully planned; and factories should continuously work on developing their talent from one level to the next (Wayne & Simpson, 2013).

## **2.6 Research Gap in the Literature**

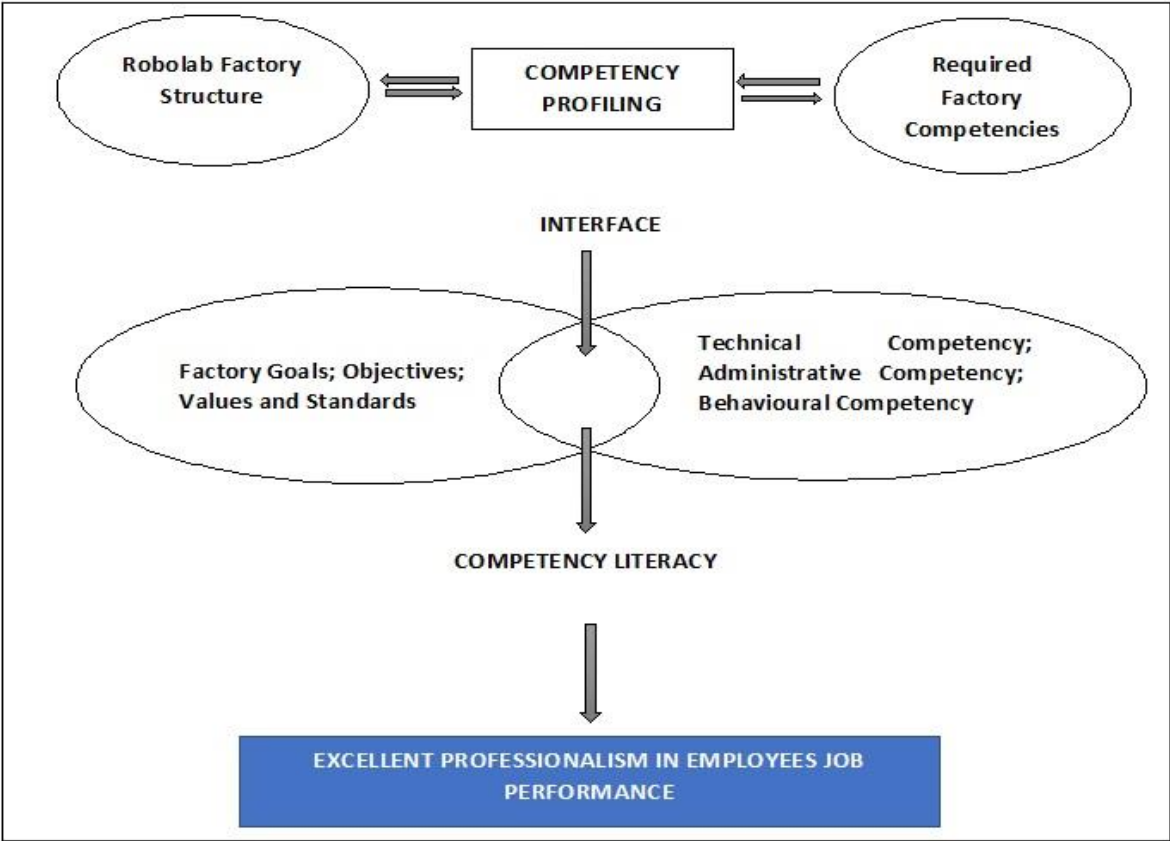
A *research gap* is defined as an area in the research about which the researcher is not able to reach a conclusive decision due to insufficient information, either from the research data or from literature reviews (Robinson *et al.*, 2011). The world of research is growing, so key issues are emerging that need researchers' attention to ensure they can provide adequate supporting evidence for making informed decisions. (Robinson *et al.*, 2013; Rowbotham *et al.*, 2016; Visvanathan, *et al.*, 2017).

This section pinpoints a gap in the literature that has raised concerns about the completeness of the current study. The current study aimed to provide information that would identify the competencies for Robolab operators within the Robotic laboratories in the cement factories.

Factories with Robolab systems place a premium on competency as a source of advantage in achieving excellent professionalism in employee's job performance (Fu *et al.*, 2017). It is evident from previous studies that employees' competency in a

Robolab is positively related to their optimal job performance (Hee Lee & Shvetsova, 2019). Scholars maintained that most automated system employees who are exceptional in their performance possess the competencies needed for automation operation (Hee Lee & Shvetsova, 2019; Rios *et al.*, 2017). However, the positive impact of competency profiling was only established from the holistic automation organisation context, thereby neglecting the integration into the profile of the extended factory structure where most Robolab systems are used. In other words, the concept of improving professionalism in Robolab operators, especially in South Africa, is yet to be included in the literature.

Although there is a positive correlation between competency profiling and excellent automation job performance, Figure 2.2 illustrates the gap in the literature about the integration of the factory competencies and Robolab competencies required for professionalism in a Robolab employee’s job performance.



**Figure 2.2 Gap in the Literature with Regard to Competency Profiling and Robolab Organisational Structure**

Figure 2.2 shows the positive impact of integrating the required factory competencies and the required Robolab competencies on employee performance. The interface represents the structural integration of the variables found in both the factory's competencies and the factory's goals, objectives, values and standards. However, a competency profiling structure for the Robolab operators in the cement factory has not been extensively exploited.

There are few arguments on the different approaches to achieving Robolab competency profiling (Tafazoli & Gómez Parra, 2017). This makes it difficult for policymakers to be concerned about the process of enhancing professionalism and optimal performance among Robolab operators. Hence, the purpose of this study to identify the specific competency profile that enhances the professional operation of the Robolab operators. As much as competency profiling in Robolab enhances employees' performance, it has also been ascertained that there is a positive relationship between competency profiling and improved state of Robolab system in the cement factory structure (Cooney *et al.*, 2018; Tafazoli & Gómez Parra, 2017).

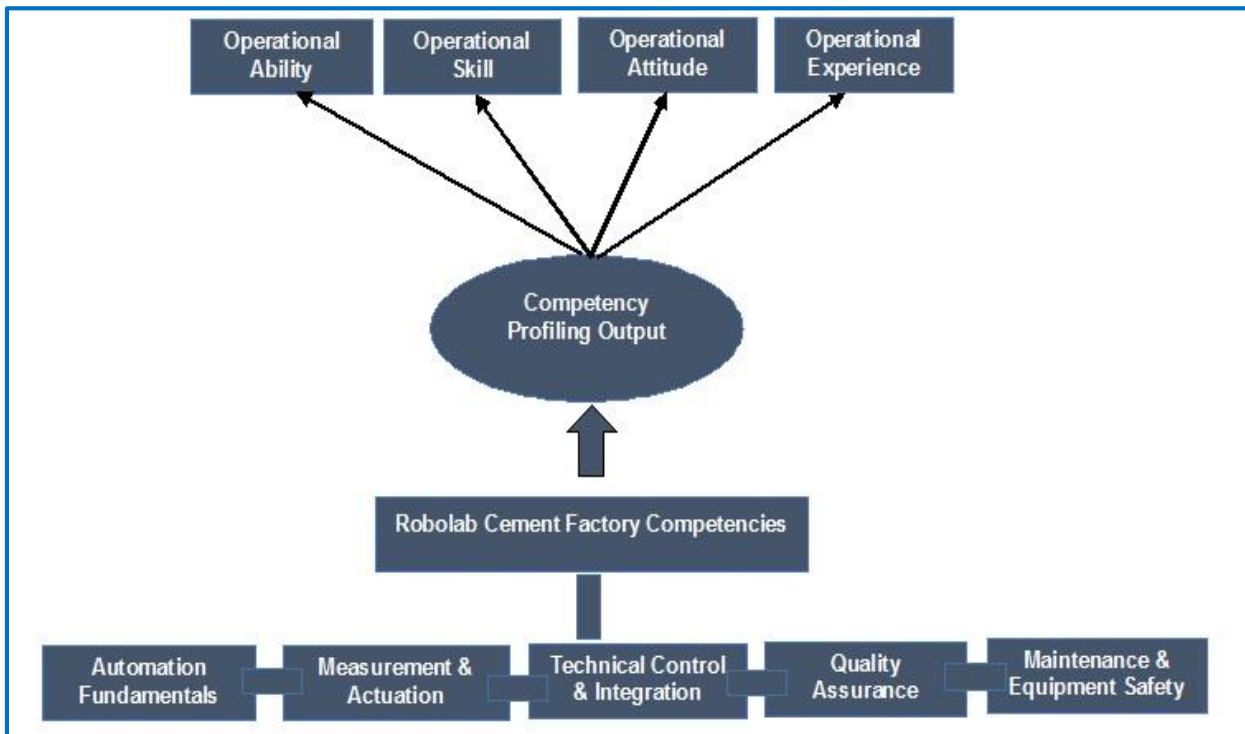
## **2.7 Conceptualising Competency Profiling Towards Professionalism of the Robolab in Cement Factories**

The analysis of competency profiling in automated factories, as presented in Section 2.5 of this study, shows that competencies are two-fold, namely technical and behavioural competencies. This informs the behavioural and technical relationship between Robolab competency profiling and employees' job performance indicated in Figure 2.3. In essence, the aim of competency profiling for the Robolab system in the cement factory is to maintain a high standard and to improve employees' competency level for excellent professional performance (Cooney *et al.*, 2018; Tafazoli & Gómez Parra, 2017). The organisation should be aware that improving the competency of the Robolab operator will also improve the behaviour of the operators.

A conceptual framework was used in this study to synergise the relationship between the needed competency structure for Robolab in the cement factory and professionalism in operation amongst employees. The conceptual framework is the researcher's synthesis of the literature to explain the concept (Ravitch & Riggan, 2012). It demonstrates an understanding of how variables connect with each other in the

study. Strong conceptual frameworks capture real ideas in a manner that can be easily remembered and applied (Eldridge *et al.*, 2016).

Since there is limited literature in the area of competency profiling in Robolab, Figure 2.3 provides a theoretical framework of competency profiling in the Robolab of the cement factory.



**Figure 2.3 Conceptual Framework of Robolab Competency Profiling in a Cement Factory**

The competencies required for a Robolab operator in the cement factory inform the competency profiling within the factory. However, a competency profiling structure is different in different automated factories (Tafazoli & Gómez Parra, 2017).

The output of competency profiling produces variables that enhance employees' operational ability, skills, attitude and experience (Basmawi & Usop, 2016; Hoffmann, 1999). Hence, the holistic integration of the competency profiling of Robolab operators in the cement factory not only enhances the organisational ability of the Robolab to achieve company objectives, but also helps the employees improve their technical and operational skills. During this process the managers of the Robolab in the cement

factories play a role in achieving organisational goals, as well as the operators (Cooney *et al.*, 2018; FLSmidth, 2016).

## **2.8 Chapter Summary**

Competency profiling has been identified from the literature as providing an adaptive structure for technological changes within cement factories with Robolabs. This chapter discussed the literature concerning competency profile development and management in organisations, as well as the benefits of organisational competency profiling. The review of the literature assisted in conceptualising how competency profiling can increase professionalism in Robolabs in cement factories.

The next chapter focuses on the research methodology used to conduct the empirical part of this study.

# CHAPTER 3.

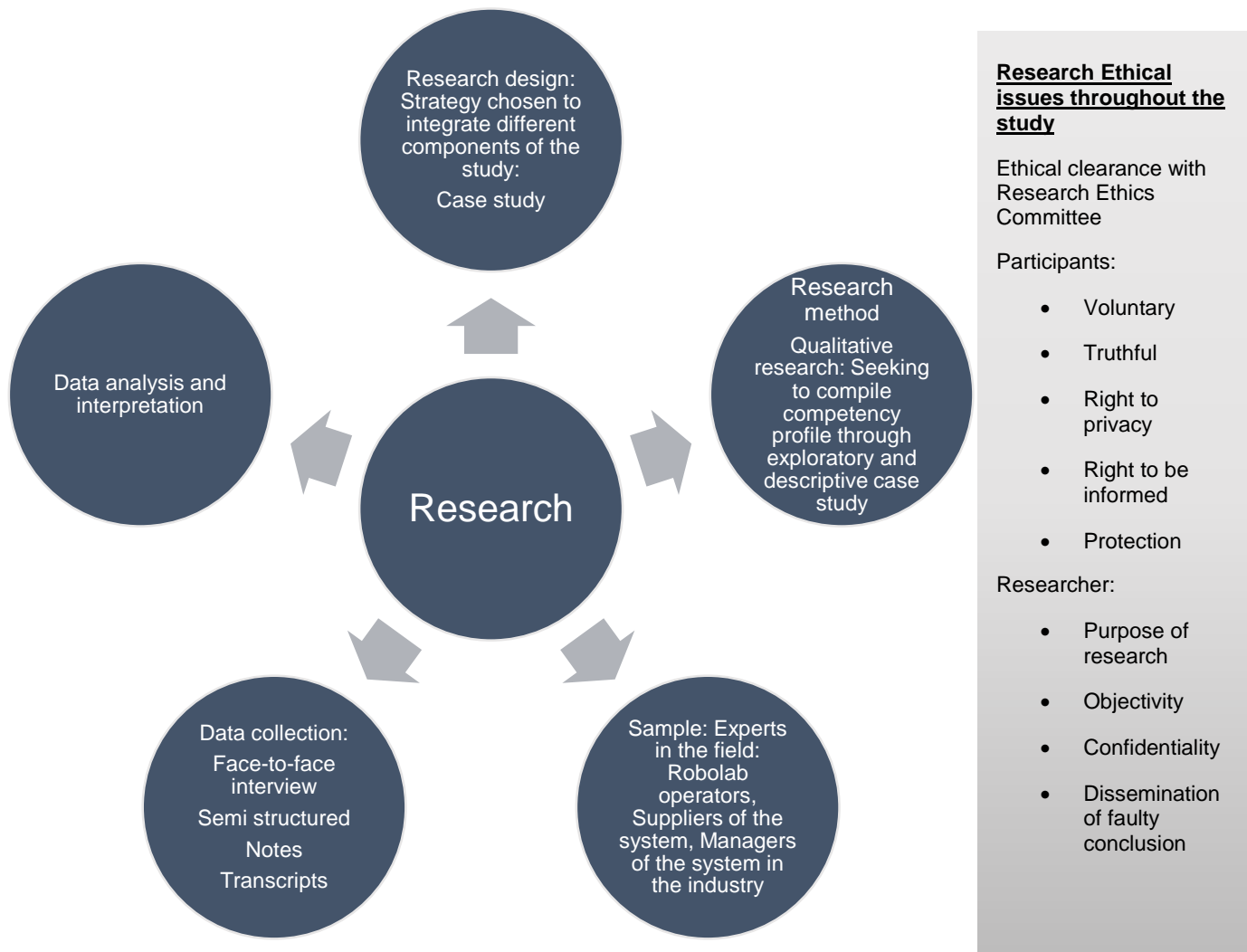
## RESEARCH METHODOLOGY

### 3.1 Introduction

This chapter explains the research design and methodology used in conducting this study, as well as the method of data analysis and the ethical considerations of the study.

Bresler and Stake (2017) defined *research methodology* as the path that the researcher has taken to get to the data collected for the study, which includes the theoretical and philosophical assumptions of the research. It also delineates the researcher's selection of the approach to conducting a research project by specifying the tools employed in the research (Leedy & Ormrod, 2010). The tools include the data collection, manipulation and interpretation mechanisms that the researcher uses.

Research involves systematic, controlled, valid and rigorous exploration and description of what is not known, as well as the establishment of associations and causation that enable accurate prediction of results under a set of conditions. Using appropriate methods is an extremely important feature of the research process. It includes identifying knowledge gaps, verifying what is already known, and identifying past mistakes and limitations (Angell *et al.*, 2015; Wildemuth, 2016). Hence, Creswell (2014:42) argues that research methodology is guided by a philosophy of research that amplifies the study's broader understanding. Figure 3.1 illustrates the research process followed.



**Figure 3.1 Research Methodology and Processes**

The choice of research methodology is based on the connection between the problem under investigation, the study objectives, the knowledge of the field of study by the researcher, the variables concerned and the study motivation. Table 3.1 presents an outline of the research questions together with the corresponding research approach, methods of data collection and analysis necessary to address the

**Table 3.1: Outline of Research Methods per Research Question**

Research question	Research Approach	Sample and Data collection method	Data analysis method
What are the requisite competencies, to be included in a competency profile, that will enhance the professional operation of the Robolab operator in a cement production factory	Exploratory and descriptive case study	Interview, company documents	Inductive thematic analysis
What are the requisite technical and behavioural competencies that other companies are using in South Africa and in other countries in similar operations?	Exploratory case study	Interviews, company documentations	Data analysis
What competency gaps and challenges exist in a Robolab cement factory?	Qualitative Interviews	Purposive and convenient sampling Interview	Thematic analysis
What are the benefits of and recommendations for an effective Robolab operating system?	Qualitative interviews	Purposive and convenient sampling Interview	Analysis of the literature and transcript themes

This chapter aims at addressing the rationale for the research methodology and methods employed in this study. Its sub-sections therefore address the following: the research approach, research design, study population, sampling method, data collection techniques and process, method of data analysis, research rigour and research ethics.

### **3.2 Research Approach**

A research approach includes the strategic guidelines and processes used in research, starting with the philosophical assumption of detailed data collection, analysis and

interpretation methods (Creswell, 2014:31; Lincoln *et al.*, 2011). The research approach informs research design and data collection methods, data analysis and the rationale for the entire process. Similarly, a research approach can be viewed as a conventional guiding principle for research practice (Joshua, 2016). According to Benoot *et al.* (2016); Bresler and Stake (2017); and Creswell (2014:31), the three major approaches in research are quantitative, qualitative and mixed-method (combining quantitative and qualitative).

A qualitative method was adopted in this study, as informed by the research questions.

### 3.2.1 Qualitative Approach

A qualitative approach to research is an approach used to explore and understand the meaning ascribed to a social or human problem by individuals or groups. The research process involves emerging questions and guidelines, data typically collected in the participants' settings, inductively building data analysis from particular to general themes, and interpretation of data (Creswell, 2014:32; Teherani *et al.*, 2015). Those involved in this type of investigation support a way to look at research that honours an inductive style, a focus on individual meaning, and the importance of investigating complex situations. Detailed below are a few characteristics associated with a qualitative approach, as posited by Creswell (2014:234):

- **Natural setting:** The researcher will normally collect the data at the site where the participants are actively experiencing the problem that is being investigated;
- **Researcher as a key instrument:** Qualitative researchers themselves collect the data that derives from studying documents, observing behaviour, or interviewing participants;
- **Multiple sources of data:** Qualitative researchers collect data in different ways, such as from interviews, observations, documents and audio-visual information, rather than relying on a single source of data;
- **Inductive and deductive data analysis:** Qualitative researchers build their patterns, categories and themes from the bottom up by organising the data into increasingly abstract information units;
- **Participants' meanings:** The researcher always upholds the true meaning of the participants' perception of the problem, learning the participants' issues without bringing the researcher's bias into it.

- **Emergent design:** The initial research plan can change as the researcher starts to collect data;
- **Reflexivity:** Enquirers reflect on how their role in the study and their personal background, culture and experiences can shape their interpretations, such as the themes they advance and the meaning they ascribe to the data; and
- **Holistic account:** Qualitative researchers attempt to develop a complex picture of the issue or issue being studied. This involves reporting multiple perspectives, identifying the numerous factors involved in a situation, and generally sketching the emerging larger picture.

Qualitative approaches follow a different scholarly enquiry from quantitative approaches to research. Although the procedures are similar, a qualitative approach deals with text data and not with statistical data (Lewin *et al.*, 2015; Teherani *et al.*, 2015). Since this study is conducted to provide a solution to a real-life situation, it is expected that employing a qualitative approach will provide a solution to the research questions raised in this study, as well as helping to achieve the research objectives.

### 3.3 Research Design

Research designs are types of enquiry within qualitative, quantitative, and mixed-method approaches that provide specific guidance for research procedures (Creswell, 2014:41; Lewis, 2015). A research design highlights the master action plan that needs to be followed in order to achieve the study's objectives. According to Creswell (2014:42), research designs are the detailed mapping of the research process; that is, the data collection, data analysis and manner of report writing.

Over the years, the number of designs available to researchers has grown, mainly due to the availability of computers and software that can handle and analyse complex data. There are therefore different kinds of qualitative design, namely narrative research, phenomenology, grounded theory, ethnographies and case study design (Abdulkadiroğlu *et al.*, 2017; Creswell, 2014:41).

Due to the nature of this study, where the case does not have all the information, the researcher had to gain an understanding of cement factories in South Africa and other countries in order to assist a specific cement factory in answering the research questions. For this reason, this research took the form of an explorative and descriptive

case study of the Robolab and its operators within a selected cement factory in South Africa.

### **3.3.1 Case Study Design**

A case study is a qualitative methodology that that does not use generalisation (Alpi & Evans, 2019:1). It is a research design that is used in its real-life context to generate a thorough, multi-faceted comprehension of a complex issue (Saunders *et al.*, 2009:177). Harrison (2017) and Yin (2012) posit that a case study design is normally used when a researcher wants to establish an in-depth understanding of a single or small case set in the real context. Case studies are also used to explain, observe and explore other phenomena within the real-life setting in a quest to shed more light on why something happened the way it did (Verner & Abdullah, 2012:870). Case study design can be used in multiple disciplines, such as the social sciences, education, business, law and health (Mills *et al.*, 2017:1).

Yin, 1989 (cited by de Weerd-Nederhof, 2001:513) gives a more technical definition – “A case study is an empirical inquiry that:

- investigates a contemporary phenomenon within its real-life context; when
- the boundaries between phenomenon and context are not clearly evident: and in which
- multiple sources of evidence are used”.

The essence of a case study is to discover why a decision was taken, how it was implemented and what the outcome of the decision was (Yin, 2014).

A case study is a study that selects one case or a small number of cases in their real-life context and analyses qualitatively the scores obtained from these cases. It should be able to capture the complexity of a single case, as that case has unique complexities and has a very special interest (Kannan *et al.*, 2015; Tetnowski, 2015). Baxter and Jack (2008) looked into the phenomenon of case study methodology as a way to provide tools for researchers to study complex phenomena within their context, and allow the researcher to define the case and the unit of analysis. The authors are of the view that defining the case is not easy.

There are three main categories of case study: exploratory, descriptive and explanatory (Zainal, 2007:3):

- **Exploratory case study:** Seeks answers to “how” and “why” questions. It explores any phenomenon in the data as a point of interest to the researcher (Zainal, 2007:3). It would normally be conducted for a problem that has not been studied clearly; it is used when the researcher seeks to explore interventions that had no clear single set of outcomes (Baxter & Jack, 2008:547; Shields & Rangarajan, 2013).
- **Descriptive case study:** Describes the natural phenomenon that occurs within the data in question (Zainal, 2007:3). It is used to describe an intervention or a phenomenon and the real-life context in which it occurs (Baxter & Jack, 2008:548).
- **Explanatory Case study:** Seeks answers to “how” and “why” questions. It is used to explain presumed causal links in real-life interventions that are too complex for a survey or experimental strategies (Baxter & Jack, 2008:547).

The case study has gained a reputation as an effective methodology for investigating and understanding complex issues in the real-world setting (Harrison *et al.*, 2017:2). According to Harrison *et al.* (2017:2) and (Mills *et al.*, 2017:1), the case study methodology has developed substantially over the last 40 years, and changes and progress have slowly moved the case study from historical approaches to reflect the preferences and perspectives of individual researchers and how they interpret their case study research.

Qualitative researchers have suggested that a case study lacks the rigour and generalisation to put what has been learned in a case study into practice (Alpi & Evans, 2019:2). However, Alpi and Evans (2019) clarified that the rigour of a case study comes from the research design and its components. Yin (2014) explained that these components are (a) the study’s questions; (b) the study’s proposition; (c) the unit of analysis; (d) the logic linking the data to propositions; and (e) the criteria for interpreting the findings (Yin, 2014).

This study adopts both exploratory and descriptive case study design to identify a specific competency profile that can enhance professional operations in the Robolab section of a cement factory. The choice of study design lies in the fact that the competency profile for the Robolab system in the cement factory has not been explored. In pursuit of documenting the competency profile for the Robolab operators,

the researcher sought answers that did not lie only within the cement factory concerned: The researcher had to look also at what are other companies with a similar system had put in place in order to operate the system effectively.

Interviews were conducted to gain an in-depth understanding of the competencies needed for Robolab operators. The researcher expected them to help obtain data that would help solve the problem statement of the study, achieve the study objectives, and clear up the uncertainty between the phenomenon and the real-life context under investigation.

### **3.4 Population and Sampling Method**

A sample is a fraction of a population selected to represent the whole, which must include elements with common characteristics. The selected sample is used to collect the data necessary for the study (Awoniyi, *et al.*, 2011; Creswell, 2014:41). According to Cohen *et al.* (2011), the population selected can affect the success or failure of the study. The researcher needs to consider a suitable sampling strategy carefully.

It is important to emphasise here that sample-based generalisation of results is the primary purpose of sampling, as well as a major concern in any scientific research (Etikan *et al.*, 2016). A representative sample will ensure that the researcher is able to draw meaningful and trusted conclusions about the entire population. According to Cohen *et al.* (2011), there are two dimensions of sampling:

- **Probability sampling:** Mostly used in a case where the researcher wishes to make a generalisation and seeks representatives of the wider population.
- **Non-probability samples:** Mostly used by a researcher who is targeting a particular group, knowing that the sample does not necessarily represent the wider population.

For this study, a purposive and convenient non-probability sampling method was employed because the researcher was targeting those who were using a Robolab system similar to that in the cement factory.

#### **3.4.1 Research Population**

Real-life research is interested in understanding a social phenomenon involving a population of some kind. A population is therefore all the people or things in a given category or group of categories (Waller *et al.*, 2015:62). Accordingly, Saunders *et al.*

(2009:212) posit that a population is the full group of potential participants amongst whom the researcher wants to conduct the research for the study. It is noted from the literature that, although different authors define population differently, they still capture the same meaning: For example, Avwokeni (2006) considers the population of a study as the collection of all participants qualifying for the study, whereas Akinade and Owolabi (2009) consider a population to be the total set of observations from which a sample is drawn for a study.

A research population has been classified into different types, including population listed, homogeneous population, heterogeneous population, non-listed population, group population, dispersed population, population grouped, target population and accessible population (Adedokun, 2003; Akinade & Owolabi, 2009).

For this study, companies that used the Robolab system, and the Robolab operators and service providers in South Africa and other countries were the population. The researcher's choice of the study's population was informed by the context of the study, wherein the cement factory in the study was the only one in the cement industry in South Africa that had a fully automated Robolab system, so not all the answers to the research question could be obtained from it. Pre-investigations showed that there was a mining laboratory in Northern Cape that had a similar system, but the system's service provider does not provide customers with a competency profile for the system.

### **3.4.2 Non-Probability Sampling**

According to Link (2018:3), in non-probability sampling methods, sampling proceeds without knowing the probabilities of selection. The researcher makes the rules as to who will be included in the sampling, or the potential respondents themselves make the decision to be included through self-selection. Cohen *et al.* (2011:155) affirm that the non-probability sampling method is normally used when the researcher is targeting a particular group.

In this study, the aim was not to generalise the competency profile of Robolab operators, but to determine the competency profile of Robolab operators of a specific Robolab supplied by a specific manufacturer to the cement industry, so non-probability sampling was suitable.

### **3.4.2.1 Purposive Sampling Method**

Purposive sampling is a non-probability sampling method where the researcher selects a fraction of the whole population based on their knowledge and professional judgement of the subject under investigation (Saunders *et al.*, 2009:237). The process involves purposively selecting individuals from the population who can best provide answers to the research question. Hence, companies that had a similar system, and Robolab service providers and operators in South Africa and other countries were selected.

### **3.4.2.2 Convenient Sampling Method**

Contrary to probability sampling, where unit selection is performed randomly, convenience sampling occurs when the units selected for inclusion in the sample are the most available and accessible (Creswell, 2014:41; Saunders *et al.*, 2009:241). Similarly, Waller *et al.* (2015:68) are of the view that convenience sampling is the selection of easily available participants in a study. The effectiveness of the sampling strategy adopted by the researcher depends purely on the researcher, so there is no one best method that can be prescribed for all researchers. Their choice will depend on the nature and objectives of the study (Palys, 2008).

The number of participants in the cement industry who can provide adequate data about competencies in Robolab systems is small. The Robolab operators and service providers in selected cement factories in South Africa were chosen based on their availability and accessibility.

### **3.4.3 Sampling Size**

Since the inclusion of all members of the population is usually not feasible, researchers select some members to participate in their study. How they do that is called sampling. The size of the sample should be enough to provide information that reflects the interests of the whole population. According to Boddy (2016:427), qualitative research has been criticised many times in the literature for not explaining the sample size used in the research. The question of how large the sample must be in order to obtain the necessary response has been asked many times (Dworkin, 2012).

It appears that the sample size for qualitative research is often smaller than that in quantitative research, because qualitative research is more concerned with gathering an in-depth understanding of a phenomenon, of “how” and “why” issues, processes or situations (Chatterjee & Diaconis, 2018). Qualitative sample sizes should be sufficient to obtain reliable data to describe the phenomenon of interest and address research objectives. As such, the qualitative researcher’s goal should be to achieve saturation and informational redundancy. Thus, qualitative research achieves saturation when additional participants in the study would not provide additional perspectives or information to details already obtained (Waller *et al.*, 2015:70).

For grounded theory, Morse (1994) emphasised that 30–50 participants are reasonable, while Creswell (1998) recommended only 20–30. For phenomenological studies, Creswell (1998) suggested approximately 5–25 participants, and Morse (1994) suggested at least six.

Considering the accessibility and availability of suitable participants in this study, seven Robolab operators and five service providers were selected for interviews. The final sample size of participants depended on the attainment of saturation and informational redundancy.

#### **3.4.4 Sampling rational**

The aim of this study was to develop a competency profile for the Robolab operators in a cement production factory in South Africa. This study would have been easy if the competency profile were available in the country or even in other countries. The skills to operate the Robolab system are not readily available in South Africa, so the study relied on interviews with Robolab laboratory operators from companies that were using the Robolab within the cement industry or another relevant industry. The population used could only be from companies that had the Robolab or that supplied it. The participant sample was made up of those who were willing to participate in the study and the researcher could not find more participants from other companies.

### **3.5 Data Collection Methods**

Different methods and techniques can be used to collect qualitative case study data, namely questionnaires, interviews, documents, archived records, direct observations,

participant-observation and physical artefacts (Alpi & Evans, 2019:2; Creswell, 2014:239; Oates, 2008). However, the choice of data collection technique depends on the research approach adopted in the study.

Since this is an exploratory and descriptive case study, current competency profiles of laboratory analysts who were intended to operate the Robolab for the company were analysed. The relevant managers in other companies were interviewed in an attempt to identify the competency needed for the Robolab operators and to identify the gap between the currently available competencies and the competency profile developed from this study.

### **3.5.1 Interview Method**

An interview is a type of data collection instrument that establishes a conversation between individuals or groups of individuals. Tracy (2013:138) defines an *interview* as a purpose-based conversation that should be organised in such a way as to serve the purpose. Interviews are classified as guided conversations to structure queries (Yin, 2009:106). The main purpose of an interview is to obtain an inside view of the experience, beliefs and motivations of individuals on a specific topic or subject under investigation (Gill *et al.*, 2008).

There are three types of interview: structured, unstructured and semi-structured (Kallio *et al.*, 2016; Thomas, 2011:162). Researchers therefore need to identify which interview is more suitable for their study. The interview method of data collection focuses on key issues that need to be addressed, and allows the interviewer and interviewee to reflect on questions or answers for clarity (Thomas, 2011:163; Gill *et al.*, 2008). According to Thomas (2011:162-163) and Gill *et al.* (2008:291), structured interviews are verbally administered questions, where the interviewer asks specific, predetermined questions with little or no deviations, while unstructured interviews are like conversations with the interviewee, with no list of questions for the interviewee. In fact, the interviewee sets the agenda and it can be time-consuming.

Table 3.2 illustrates the strengths and weakness of semi-structured interviews, as posited by Yin (2009:102) and Gill *et al.* (2008). The table informs the researcher what strengths and weaknesses to note when conducting the interviews.

**Table 3.2 Strengths and Weakness of Semi-Structured Interview** (Adapted from Gill *et al.*, 2008; Yin 2009:102)

Strength	Weakness
It focuses directly on the case topic	It can be biased due to poorly constructed questions
Provides participants with guidance	Reflexivity – the interviewee might give what the interviewer wants to hear
The approach is flexible as it allows the elaboration of information	

### 3.5.2 Semi-structured Interviews

Semi-structured interviews combine the best of structured and unstructured interviews. They address key issues and allow both interviewer and interviewee to reflect and ask follow-up questions for clarity (Thomas, 2011:163; Gill *et al.*, 2008:291).

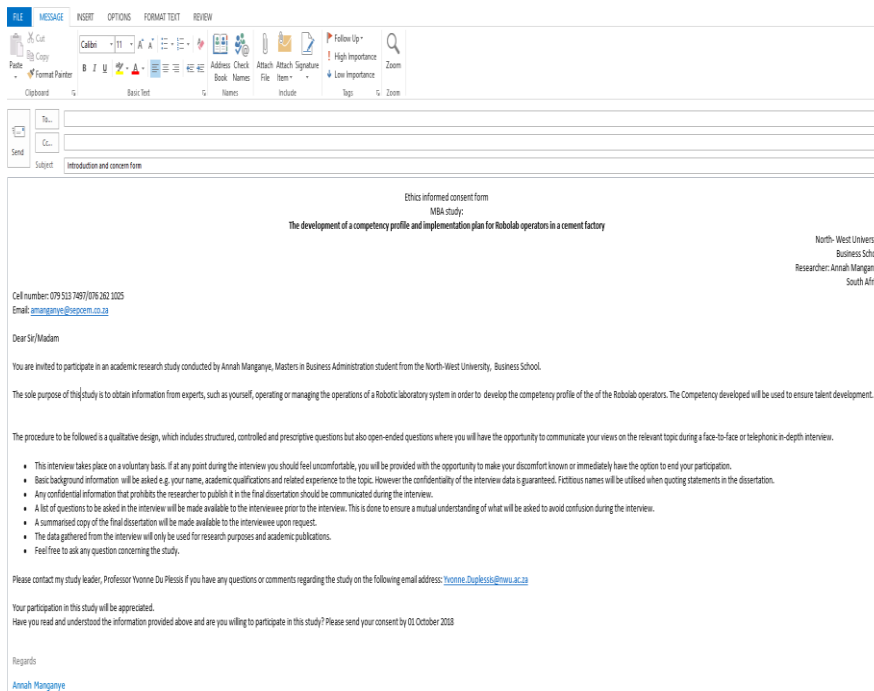
For this study, a semi-structured interview was adopted, to enable more questions, observations and follow-up questions to be asked.

### 3.5.3 Interview Process

An interview process is a pre-planned event, which means the discussion agenda is set before the interview begins; it can be done face-to-face, by telephone or through email. Participants were invited to participate in this study by email.

According to Qu and Dumay (2011), the interviewer needs to maintain the flow of the interview process by maintaining a positive relationship with the interviewee and avoid being bias throughout the interview.

Due to the location of the participants, three modes of interview were used, namely the face-to-face interview, telephonic interview and sending the interview questions by emails. The first email was an introductory email (Figure 3.2) explaining the intentions and reasons for the invitation.



**Figure 3.2 Example of an invitation email sent to participants**

A second email requested an interview, with an attachment of possible interview questions as in addendum C. The participants gave their consent and confirmed their availability for the interview by email. The interview questions were structured to answer the research questions outlined in Section 1.6. Participants were notified of their rights to withdraw from the interview at any point if they felt they could not continue, and permission to record the conversation was obtained.

**Table 3.3 Interview schedule**

Interviewee number	Interview date	Interview location	Interview	Designation	Duration of the interview
1	01/11/2018	Kuruman	Face-to-face	Manager	1.5 hours
2	01/11/2018	Kuruman	Face-to-face	Manager	1.5 hours
3	02/10/2018	Kuruman	Face-to-face	Operator	1 hour
4	30/10/2018	Johannesburg	Face-to-face	Service manager	1.5 hours

<b>Interviewee number</b>	<b>Interview date</b>	<b>Interview location</b>	<b>Interview</b>	<b>Designati on</b>	<b>Duration of the interview</b>
5	30/10/2018	Johannesburg	Face-to-face	Service Manager	1.5 hours
6	03/11/2018	Johannesburg	Face-to-face	Manager	1.5 hours
7	04/11/2018	India	Email	Service Manager	2 hours
8	04/11/2018	Denmark	Email	Service Manager	2 hours
9	04/11/2018	Germany	Email	Manager	2 hours
10	06/11/2018	Lichtenburg	Telephonic	Operator	1 hour
11	06/11/2018	Lichtenburg	Telephonic	Operator	1 hour
12	06/11/2018	Lichtenburg	Telephonic	Operator	1 hour
13	06/11/2018	Lichtenburg	Telephonic	Operator	1 hour

The interview question had two sections, the first of which focused on obtaining information about the personal profile of the participants, and the second of which comprised the questions related to the objective of the study.

The interview session started with the interviewer introducing herself, along with the objectives of the research. The interviewer asked for the consent of the participant to take part in a recorded interview. Some participants agreed to be recorded and some did not. For the participants who did not agree to be recorded, the researcher took notes and followed up by telephone for more clarity where needed. The researcher proceeded to ask questions as they were structured according to the interview guide, and gave the interviewee sufficient time to answer the questions, and elaborate if they wished.

Thomas (2011:171) advises that all data needs to be examined and that electronic copies should be made of all the raw data. Hence, an electronic folder of all collected data was created for each participant and stored on a laptop and an external hard drive

to avoid loss of data. A secondary working folder was created on the laptop, where data could be highlighted or underlined or notes could be added to the data. This was done so that the raw data was available in case the working folder was corrupted.

### **3.6 Method of Data Analysis**

Qualitative data analysis is a process of transforming the collected data into a form of explanation, understanding or interpretation of the individuals and situations under investigation. Accordingly, qualitative data analysis is typically based on an interpretative philosophy. It is important for the researcher to keep in mind that interview data collection and analysis can occur concurrently (Baxter & Jack, 2008; Creswell, 2014:246). As data is collected, it can also be analysed in order to maximise the concept. Qualitative data analysis is the categorisation and interpretation of linguistic (or visual) material to express implicit and explicit parameters and context-making structures in the material and what is represented in it (Creswell, 2014:245).

Qualitative data can be analysed using two fundamental approaches, namely deductive and inductive approaches (Burnard *et al.*, 2008; Saunders *et al.*, 2009:489). Case study researchers often use the inductive approach. Sekaran and Bougie (2016:350) point out that qualitative data analysis includes content analysis, thematic analysis, narrative analysis, discourse analysis, framework analysis and grounded theory.

For this study, a thematic method of data analysis was employed.

#### **3.6.1 Thematic Analysis**

Thematic analysis is a data analysis tool used to determine the presence within texts or sets of texts of certain words or concepts. It involves a procedure for categorising verbal or behavioural data for classification, summary and tabulation purposes (Sekaran & Bougie, 2016:350; Stemler, 2015). The idea is to examine the meaningful and literal content of qualitative data collected. Thematic data analysis identifies themes and categories that emerge from the data (Sekaran & Bougie, 2016:350). This process involves discovering themes in the interview transcripts and attempting to verify, confirm and qualify them by searching throughout the data, and repeating the process to identify further themes and categories (Burnard *et al.*, 2008). The

researcher needs to organise the data, identify the framework, sort the data into the framework, and use the framework in descriptive analysis.

### **3.6.1.1 Organising the Data**

This step involves transcribing data, translating it, cleaning it and labelling it (structuring and familiarising). The first step in data analysis is to transcribe and manage the data collected (Stuckey, 2015:7). After this stage, the researcher read through the data and prepared it to be analysed using the ATLAS.ti 6 as recommended by Friese (2019:5). Before the researcher can load the data on ATLAS.ti, files need to be prepared as per its specifications; for example, data must be in Word document format and the right margins need to be about 7 cm in order to leave room for the software activities.

### **3.6.1.2 Identify framework**

This step helps to structure, label and define data and the coding plan. Transcripts from the recordings were prepared and a comprehensive table of all participants and their responses was put together to ensure that all responses from all participants were captured.

### **3.6.1.3 Sort Data into Framework**

This step involves coding the data and modifying the framework. Coding can be done manually or by using qualitative data analysis software such as ATLAS.ti 6.0, NVivo, HyperRESEARCH 2.8 (Stuckey, 2015:7). According to (Saldaña, 2013:3) coding in a qualitative enquiry is a word or short phrase that symbolically assigns a summative, salient, essence-capturing and or evocative attribute to a portion of language-based or visual data.

The data was prepared for ATLAS.ti coding and themes.

### **3.6.1.4 Use Framework in Descriptive Analysis**

This step arranges the responses in categories and identifies recurrent themes (Smith & Firth, 2011:3). During this process, the researcher ensures that the captured themes represent the participants' responses. This was achieved by cross-referencing the themes to the transcripts.

Thematic analysis offers several advantages, which include providing insight into complex human thinking and language usage models, providing valuable historical/cultural insights over time by analysing texts; it is therefore at the heart of social interaction (Smith & Firth, 2011:3).

### 3.7 Trustworthiness

Trustworthiness is necessary in both quantitative and qualitative studies. Its focus in a quantitative study is on establishing the validation and reliability of the instrument used in the study. In a qualitative study, it addresses how the researcher establishes that the findings in the study are credible, transferable, confirmable and dependable (Creswell, 2014:240). Gunawan (2015:4) is of the view that many qualitative researchers fail to give an adequate description of their assumptions, methods and data analysis in their research reports.

It is necessary for researchers to ensure they establish the protocols and procedures necessary for them to be considered worthy of consideration by readers (Connelly, 2014:2; Elo *et al.*, 2014:2). As cited by Elo *et al.* (2014:2) and Connelly (2016:1), Lincoln and Guba (1985) described four criteria that should be considered when assessing the trustworthiness of the study. According to Connelly (2016), these criteria have been accepted by many qualitative researchers to validate the trustworthiness of qualitative research. The criteria are:

- **Credibility** – how confident the qualitative researcher is about the truth of the findings of the study;
- **Transferability** – how the qualitative researcher demonstrates that the research study's findings are applicable to other contexts;
- **Conformability** – the degree of neutrality in the research study's findings; and
- **Dependability** – the extent to which the study could be repeated by other researchers with findings that would be consistent.

The researcher attended to these four variables in order to uphold the trustworthiness of this study as described below.

### **3.7.1 Credibility**

Its credibility is seen as the most important criterion of a qualitative study (Connelly, 2016). For qualitative research to be credible, it should adhere to data collection procedures that are well defined and accepted across the community of researchers (Sarma, 2015:183). Researchers should be able to describe explicitly the way they prolonged their engagement with their participants to ensure they documented the truth of their participants' views correctly. The researcher should also give full details of how data was collected, analysed and interpreted (Quick & Hall, 2015:131).

In this study, the researcher kept in touch with the participants after the initial interview session to gain clarity on the data collected. The researcher also visited sites that had Robolabs to observe a competent Robolab operator operating the system. The researcher familiarised herself with an operational Robolab system in a cement factory to observe the challenges outlined by the operators.

### **3.7.2 Transferability**

According to Elo *et al.* (2014:2), transferability refers to the possibility of extrapolating the findings to a different setting. Even though the population might be different, other researchers should be able to apply the findings of the study to their own setup.

Robolab systems are not only used in cement manufacturing factories. The system can be used in other industries to replace manually operated equipment in the laboratories. Transferability in this study was ensured by involving the manufacturers or service providers of the Robolab system. The participants selected provided a rich source of information as they were directly involved in the day-to-day running of Robolab system. Furthermore, two participants were from the mining sector and some were from Germany, India and Denmark. Therefore, other researchers will be able to use a similar methodology in a similar setup.

### **3.7.3 Conformability**

Conformability ensures that the findings of the study are purely the ideas of the participants. In most cases, if not all, researchers bring their skills, experience, knowledge and, possibly, biases to the process (Tong & Dew, 2016).

The researcher has ensured that all records obtained during the process of this study are available to assist any future researchers, who might be interested in pursuing the study further.

#### **3.7.4 Dependability**

According to Polit and Beck (2014), as cited by Connelly (2016:435), dependability refers to the stability of data of the study over time in diverse conditions. Keeping notes throughout the study is essential. These notes can include whom to interview, where, at what time, and what happened during the data collection (Gunawan, 2015).

In this study, dependability was adhered to by ensuring that the assumptions, method and process followed are established, as well as record-keeping of data collected throughout the study.

#### **3.8 Research Ethics**

Research ethics provide guidance on the responsible conduct of research. It also educates and monitors researchers to ensure a high ethical standard. Accordingly, there are no ethical bias or violation issues in this study. Ethical approval was obtained from the North-West University Ethics Committee before issuing the data collection interview questions. The researcher obtained the consent of the participants by briefing them on the objectives and benefits of the study. The degree of confidentiality of the information that they provide has been assured: All information is confidential and all secondary sources consulted have been acknowledged. The following principles and guidelines were adhered to in the study:

- The research maintained a high level of objectivity and integrity;
- All references and sources used were captured in the reference section and authors were cited in the text;
- A recognised research approach was followed;
- High levels of values, norms and standards were maintained;
- The purpose and objective of the study was explained to the participants;
- The interview questions were sent to participants beforehand and were clearly explained to the participants;

- Information about the participants was not disclosed to the public and was used solely for the purposes of this study;
- Research results have been disseminated in an open and transparent manner; and
- The required consent forms were submitted before approaching participants for interview.

### **3.9 Chapter Summary**

This chapter has provided a detailed outline of the research methodology used in this study. The research approach and research design were explained, and how they fit into the study was discussed. The target population, sampling method, and the techniques used for data collection and data analysis were examined. The study's trustworthiness and ethics were attended to.

The next chapter focuses on data analysis, results and findings.

# **CHAPTER 4.**

## **DATA ANALYSIS AND PRESENTATION OF RESULT AND FINDINGS**

### **4.1 Introduction**

This chapter analyses, interprets and discusses the data and presents the results and findings obtained from the qualitative data collection process.

Even though 15 participants were targeted, only 13 participants were interviewed. There was no need for the researcher to pursue more participants as no new information emerged.

In a qualitative study, the concept of saturation is more important than the sample size (Dworkin, 2012:1319). Dworkin (2012) describes saturation as the process whereby the collected data no longer offers new or relevant data. Because of this argument, it can be concluded that this research has acquired sufficient information to arrive at valid findings. The results of the research are presented in the sections that follow.

### **4.2 Presentation of Results**

The researcher transcribed all interviews to readable text to enhance comprehension. A thematic analysis was adopted to ensure that responses by each participant were grouped by subject and according to each research question.

In the presentation phase, the biographic information of the participants is presented, followed by the themes and categories of findings from each research question. To maintain anonymity in this study, participants were given pseudonyms. Table 4.1 presents the participants and their pseudonyms.

**Table 4.1 Pseudonyms of the participants**

<b>Participants</b>	<b>Pseudonyms</b>	<b>Job Designation</b>
Participant 1	RO1	Manager
Participant 2	RO2	Manager
Participant 3	RO3	Manager
Participant 4	RO4	Manager
Participant 5	RO5	Manager
Participant 6	RO6	Manager
Participant 7	RO7	Manager
Participant 8	RO8	Operator
Participant 9	RO9	Operator
Participant 10	RO10	Operator
Participant 11	RO11	Operator
Participant 12	RO12	Supervisor
Participant 13	RO13	Operator

The pseudonyms presented in Table 4.1 are used in the interpretation section to highlight the excerpts from the interviews with each participant.

#### **4.2.1 Presentation of Biographic Information**

The biographic information or the personal characteristics of the participants, such as years of experience and highest educational qualification, are presented in this phase. Tables and charts were used to represent the information gathered from the interviews.

##### **4.2.1.1 Years of Work Experience**

Participants in the study were asked to indicate their years of work experience because they needed rich knowledge and experience of the operation of the Robolab system in order to give relevant and detailed information about the competencies needed by an operator. The responses gathered in this category are presented in Table 4.2.

**Table 4.2 Years of Work Experience**

<b>Years of Work Experience in Robolab Factory</b>	<b>Frequency</b>
5 and below	2
6–15	9
16–25	2
25 and above	-
<b>Total</b>	<b>13</b>

Table 4.2 shows the years of work experience with the Robolab system possessed by participants. The majority of the participants had spent more than six years in the operation of the Robolab system. These experienced participants can be relied upon to give valuable information about the operation of the Robolab system.

#### **4.2.1.2 Educational Qualifications**

The participants were asked to indicate their educational qualifications. This was relevant as it indicated whether the participants had the necessary knowledge to give credible information. Their responses are presented in Table 4.3.

**Table 4.3 Educational Qualifications**

<b>Educational Qualification Obtained</b>	<b>Frequency</b>
Matric	1
Technical Qualification	4
Bachelor's Degree	5
Master's Degree	2
Doctor of Philosophy	1
<b>Total</b>	<b>13</b>

The results in Table 4.3 show that the participants had higher learning qualifications. Education is viewed as an investment in the knowledge and skills of the people. It plays a crucial role in increasing the innovation capabilities of people by informing them about new technological ideas (Woessmann, 2016:3). It is believed that the participants had a sufficiently high educational background to elaborate and give reliable information to the study.

**4.2.1.3 Nationality**

Other countries had to be included in the study because no information was available about competency profiles in the researched cement company and in the literature. Table 4.4 therefore records the nationalities of participants.

**Table 4.4 Nationality**

<b>Nationality</b>	<b>Frequency</b>
South Africa	10
Denmark	1
India	1
Germany	1
<b>Total</b>	<b>13</b>

According to Table 4.4, most of the participants were from South Africa.

**4.3 Presentation of Transcribed Results**

This section presents the results and initial coding of the transcriptions from the interviews. The data from the interviews were analysed and presented according to the research questions of this study. There are three major research questions in this study and the responses were coded into meaningful sub-units. Categories were generated in each research question and are represented in the tables below.

All the participants (RO1-RO13) contributed to these responses tabulated on Table 4.5 to Table 4.17

## 1. What is the major purpose of the Robolab Operator?

**Table 4.5 Purpose of the Robolab operator**

Theme	Initial Codes	Description
Purpose of the Robolab operator	* Operate the system * Daily maintenance * Update logbook * Analyse process sample * Interpret data * Chemical analysis * Laboratory analysis *	This theme referred to the purpose of the Robolab operator

The Initial Codes column in Table 4.5 summarises the responses from the participants. All the participants were of the view that the primary role of the Robolab operator is to operate the Robolab in automatic mode, using software to command the machines to sample, prepare and analyse the sample and report the results.

## 2. What are the day-to-day duties of the Robolab operator?

**Table 4.6 Duties of the Robolab operator**

Theme	Initial Codes	Description
Duties	* Daily maintenance * Troubleshooting * Maintain logbook * Analyse hourly process samples * Maintain analytical equipment * Safety check on the equipment * Report breakdowns * Analyse samples * Data interpretation * Respond to equipment alarms * Report equipment breakdown * Analyse project samples * Housekeeping * Conduct pre-use checks * Load samples for preparation * Load samples for analysis * Assess results * Report results * First-line maintenance * Analyse standards * Operate the system in auto mode * Minor parts replacement * Resolve equipment alarm * Manual sampling * Manual analysis * Manual sample preparation * Report issues pertaining to equipment *	This theme referred to participants' understanding of the day-to-day duties of the Robolab operator

### 3. What job experience is required for the Robolab operator?

**Table 4.7** *Job experience for the Robolab operators*

<b>Theme</b>	<b>Initial Codes</b>	<b>Description</b>
Required operational job experience of a Robolab operator.	* None * Analytical chemistry * Cement chemistry * Sample analysis * Good laboratory practice * Mechanical experience * Sample preparation * cement process * Analytical engineering * IT knowledge * Chemical laboratory * Electrical experience * Sample analysis * Laboratory experience * Robotic operation skills	This theme was used to establish the job experience required of a Robolab operator.

**4. What educational qualifications do you recommend for the Robolab operator, if any?**

**Table 4.8 Required educational qualifications**

<b>Theme</b>	<b>Initial Codes</b>	<b>Description</b>
Required educational qualification of a Robolab operator.	* Matric * Analytical chemistry * Chemistry qualification * Maths qualification * Mechanical qualification * Analytical qualification * Electrical qualification * Science qualification	This theme referred to the educational qualifications required of a Robolab operator.

**5. What are the technical competencies for the Robolab operator?**

**Table 4.9 Required technical competencies**

<b>Theme</b>	<b>Initial Codes</b>	<b>Description</b>
Required technical competencies of a Robolab operator.	* Ability to interpret report * Technical confidence * Knowledge in cement process * Adjust to routine schedule * Laboratory methodology * Equipment maintenance * Chemistry knowledge * Ability to communicate * Mechanical knowledge * Equipment assessment * Robotic operation skills * Ability to be attentive * Deal with challenges * Electrical knowledge * Focus * Sample preparation * Process knowledge * Flexible * Attention to details * Knowledge of ISO 9001 * Assertive * Calmness * Innovative * Hand tools * Team worker * Logical sense * Technical skills * Analytical skills * Computer skills * Care for details * Planning ability * Identify patterns * Manage pressure * Willingness to learn	This theme referred to the technical competencies required of a Robolab operator.

## 6. What are the behavioural competencies for an operator?

**Table 4.10 Required behavioural competencies**

Theme	Initial Codes	Description
Required behavioural competencies of a Robolab operator.	<ul style="list-style-type: none"> <li>* Creative and judgement</li> <li>* Care and skilled attitude</li> <li>* Encourage team spirit</li> <li>* Performance-oriented</li> <li>* Truthful</li> <li>* Understanding issues</li> <li>* Give feedback</li> <li>* Good attitude</li> <li>* Championing team</li> <li>* Performance focus</li> <li>* Results driven</li> <li>* Strategic oriented</li> <li>* Encourage others</li> <li>* Initiate changes</li> <li>* Business-driven</li> <li>* Strategic action</li> <li>* Willing to work</li> <li>* Responsible</li> <li>* Honest</li> <li>* Accountability</li> <li>* Self-motivated</li> <li>* Calm</li> <li>* Handle stress</li> <li>* Customer focus</li> <li>* Hands on</li> <li>* Hardworking</li> <li>* Persistence</li> <li>* Integrity</li> <li>* Patience</li> <li>* Accountability</li> <li>* Risk reduction</li> <li>* Develop partnership</li> </ul>	This theme referred to participants' understanding of the behavioural competencies required of a Robolab operator.

## 7. What are the work challenges that Robolab operators face?

**Table 4.11 Work challenges faced by Robolab operators**

Theme	Initial Codes	Description
Work challenges faced by a Robolab operator.	<ul style="list-style-type: none"> <li>* Shortage in sample supply</li> <li>* Lack of competent support</li> <li>* Poor training</li> <li>* Mechanical issues</li> <li>* Damage sample</li> <li>* Logbook not updated</li> <li>* No remote technical assistance</li> <li>* System errors</li> <li>* Fear of taking control</li> <li>* Being multi skilled</li> <li>* Not understanding the error codes</li> <li>* No experience</li> <li>* Maintenance problem</li> <li>* Sampling at night shift</li> <li>* Limited laboratory experience</li> <li>* High quantity of sample</li> <li>* Unavailable plant engineers</li> <li>* Analytical chemistry</li> <li>* Error message</li> <li>* Equipment breakdown</li> </ul>	This theme referred to participants' understanding of the work challenges faced by a Robolab operator.

**8. What are the general challenges that companies face with regard to the Robolab system?**

**Table 4.12 Robolab challenges faced by companies**

Theme	Initial Codes	Description
Robolab challenges faced by the company.	* High cost of upgrade * Limited support system * High cost of maintenance * No info-laboratory system * High cost of spares * Expensive machine * Managing staff * Unskilled operators * No budget for plant * High cost of training * Limited plant information * Equipment maintenance * Poor service technicians * Expensive technical support * Limited remote diagnosis * System modification – competent data management system * Poor initial planning	This theme referred to participants' understanding of the Robolab challenges faced by the company.

**9. In your opinion, is the skill of being a Robolab operator readily available in the country?**

**Table 4.13 Robolab skill availability**

Theme	Initial Codes	Description
Readily available skill	* Not available * Unique system * New technology	This theme referred to participants' understanding of the availability of skilled Robolab operators within the talent pool.

**10. Do you have a development plan to get the Robolab operators to be competent?**

**Table 4.14 Availability of training**

Theme	Initial Codes	Description
Availability of training	* Training is available * Training modules * Robolab operator training * Maintenance team training	This theme referred to participants' understanding of the availability of training to enable the Robolab operator to be competent at operating the system

**11. What did your company need that led to the acquisition of the Robolab system?**

**Table 4.15 Reasons why companies acquire the Robolab system**

<b>Theme</b>	<b>Initial Codes</b>	<b>Description</b>
Reasons why companies acquire Robolab.	* Complement human effort * Eliminate production error * Easy operation process * Quick result reporting * Quick sample analysis * Sample error reduction * Sample management * Maximise production * Less manual labour * Error-free sampling * Minimise overtime * Timely production * Quality sampling * Less human error * Accurate report	This theme was used to obtain information about why the company acquired Robolab.

**12. What operational challenges did you encounter with the Robolab system?**

**Table 4.16 Operational challenges with the system**

<b>Theme</b>	<b>Initial Codes</b>	<b>Description</b>
Operational challenges with the Robolab system.	* Spares availability * Poor initial planning * No sufficient budget * Lack of senior management support * Wear out of equipment component * ROI not thoroughly investigated * Customer located in remote areas * Lack of skill to maintain system * Unable to handle breakdown * No competent personnel * Too far technical support * No OEM maintenance plan	This theme was used to obtain information on the operational challenges that companies experienced with the Robolab system.

### 13. Recommendation for effective operation of the Robolab system

**Table 4.17 Recommendations for an effective Robolab system**

Theme	Initial Codes	Description
Way forward for effective Robolab system.	* Competent maintenance team * Stakeholder involvement * Research on the machine * Available info-laboratory system * Budget for maintenance * Operational consistency * Maintenance technician * Employ competent staff * Technological upgrade * Cleaning plant environs * Good initial planning * Have stock of spares * Proper maintenance * Backup chemist * Staff training	This theme referred to participants' understanding of the way forward for an effective Robolab system.

#### 4.4 Presentation of Findings: Themes and Categories

In this phase, themes and categories were generated from the transcribed data in order to identify the concepts that addressed the study's research question. Coding was done to relate each response to its theme.

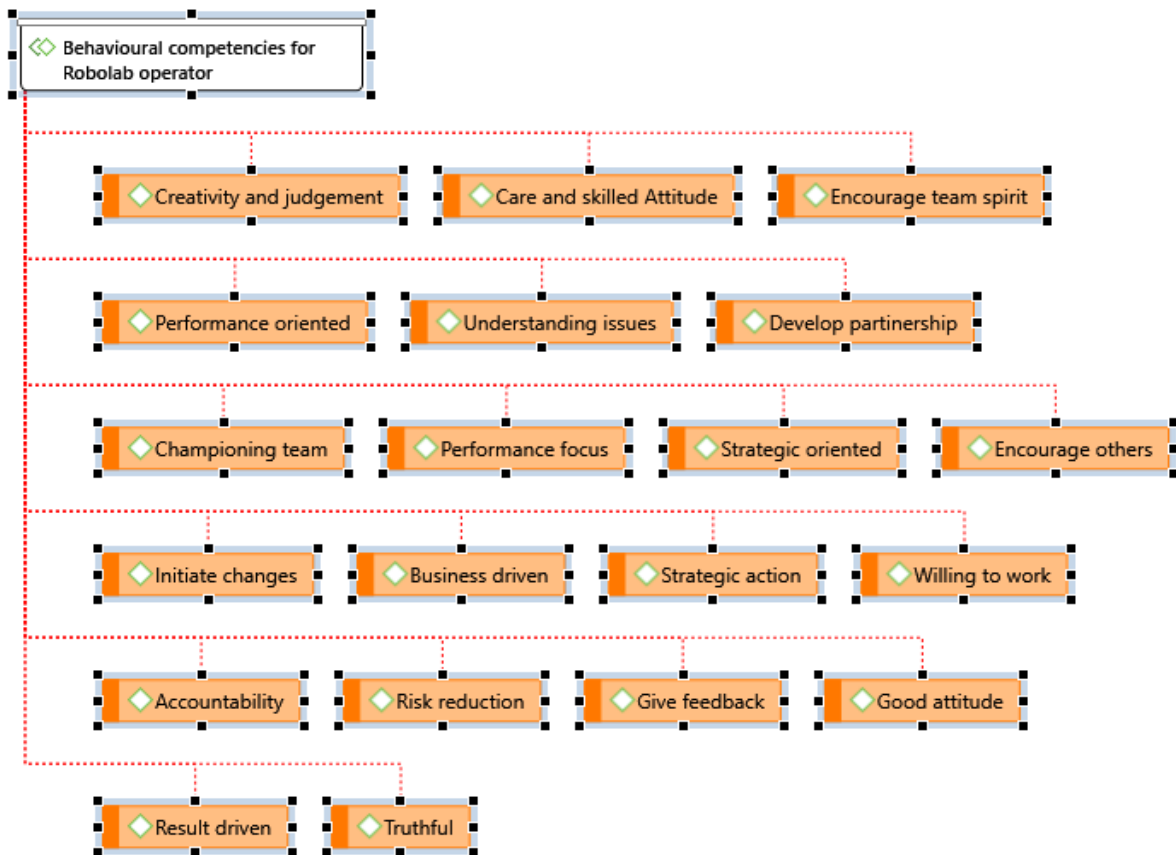
According to Maree (2015), data coding is a process whereby the researcher transcribes data and categorises it into small units and sub-units, then categories them according to the research questions. During this process, the data is compared to establish themes, trends and patterns. The emerging themes are cross-referenced with the research questions to ensure that the investigation stays on track. Related topics are then categorised and data materials belonging to each category are grouped together.

The themes and categories of this study are presented below:

##### 4.4.1 Themes on the Requisite Competencies of a Robolab Operator

This section of the study examined the participants' understanding of the competencies required by a Robolab operator. This theme is therefore in line with the study objective to identify the necessary competencies that enhance Robolab operation. Participants were asked to provide the behavioural competencies of a Robolab operator and the

use of ATLAS-ti network helped in identifying these competencies, as presented in Figure 4.1.



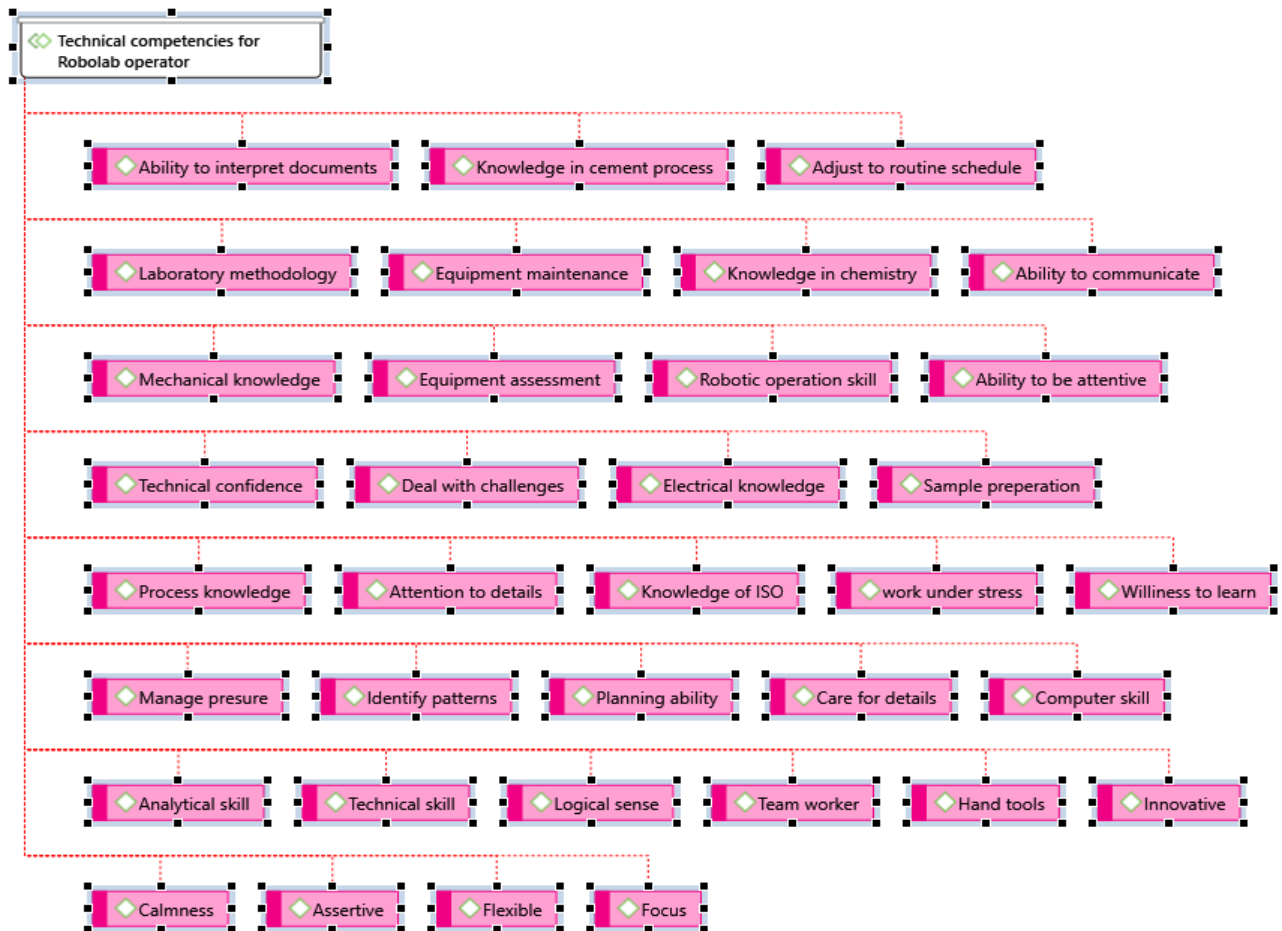
**Figure 4.1 Required behavioural competencies for a Robolab operator**

Figure 4.1 shows that the participants expressed their understanding of the required behavioural competencies that would enhance the operation of a Robolab. Behavioural competencies such as strategic action, willing to work, creativeness, judgement, care, skilled attitude, encourage team spirit, performance-oriented, truthful, understanding issues, give feedback, good attitude, championing team, performance-focus, results-driven, strategy oriented, encourage others, initiate changes, business-driven, accountability, risk reduction and development of partnership were named as core competencies that a Robolab operator needs to possess to optimise his performance. The following excerpts were extracted from the transcript of participants' comments on the behavioural competencies required by a Robolab operator (Table 4.18):

**Table 4.18 Quotes re behavioural competencies**

<b>Themes</b>	<b>Illustrative Quote</b>
Creative and judgement	RO4: Many modifications on the system were done because of the suggestions from the operators.
	RO2: Operators need to give input on the improvement of the equipment and system.
Care and skilled attitude	RO3: The operator need to exercise care and high skill for the equipment.
	RO4: The operator need to care for the equipment and love it enough to do simple daily maintenance of it.
	RO6: A Robolab operator must possess both positive and learning attitude towards machine problem-solving, as well as the ability to champion team and change leadership.
Encourage team spirit	RO6: Breakdown can really demoralise the operators, so the operators must be able to work as a team, share ideas and encourage each other.
Performance orientated	RO1: The operator must set high standard and be proactive.
	RO3: The operator need to be results orientated
Understanding Issues	RO7: The operator need to be able to identify and recognise any change in the sound and smell in the Robolab system.

In a follow-up question, participants were asked to state the technical competencies required by a Robolab operator to exercise efficiency in Robolab operation. Their responses are presented in the ATLAS-ti network diagram in Figure 4.2.



**Figure 4.2 Technical competencies required by Robolab operators**

Figure 4.2 provides the responses from participants with respect to the technical competencies required for an operator to enhance the operation of a Robolab system. Technical competencies such as ability to interpret documents, technical confidence, knowledge in cement process, adjust to routine schedule, laboratory methodology, equipment maintenance, chemistry knowledge, ability to communicate, mechanical knowledge, equipment assessment, robotic operation skills, ability to be attentive, deal with challenges, electrical knowledge, focus, sample preparation, process knowledge, flexible, attention to details, knowledge of ISO 9001, assertive, calmness, innovative, hand tools, team worker, logical sense, technical skills, analytical skills, computer skills, care for details, planning ability, identify patterns, manage pressure and willingness to learn were named as relevant for a Robolab operator.

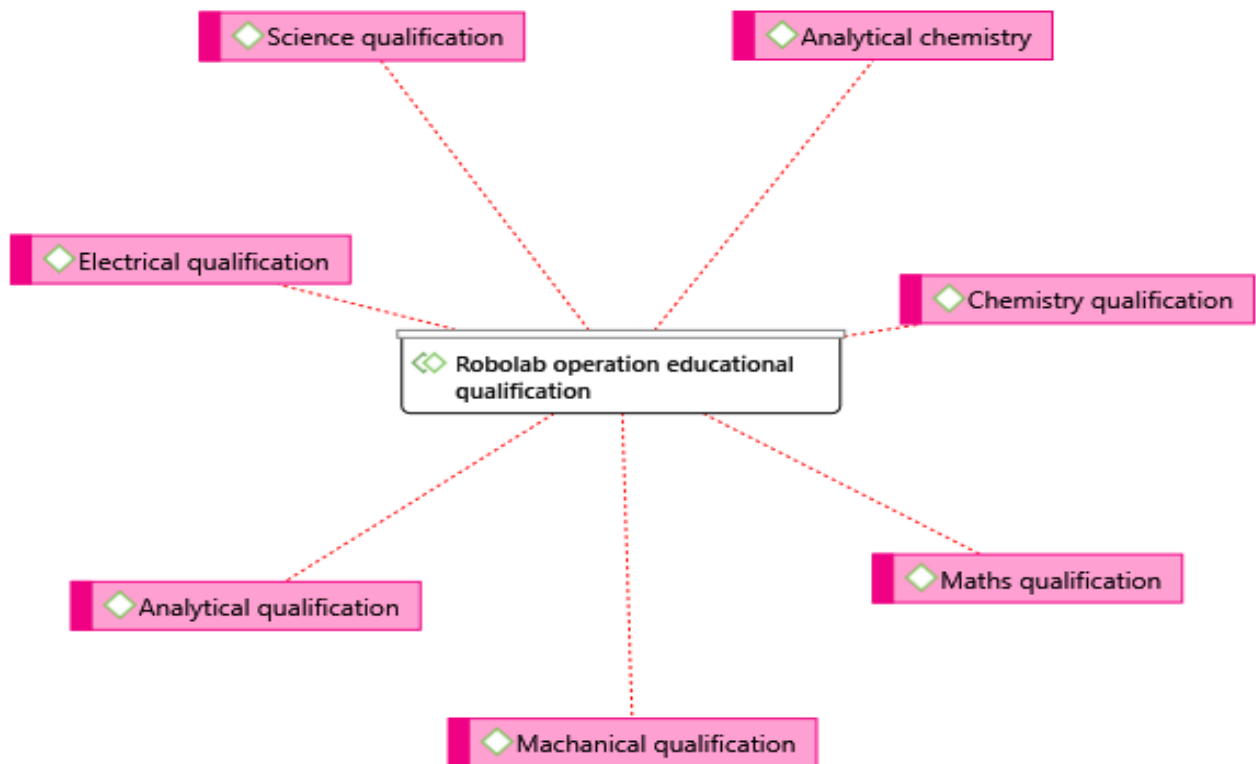
The analysis of this theme revealed that, for efficient and effective operation of Robolab, an operator must possess a great percentage of these outlined technical competencies. It also emerged that companies interviewed had no position classed as

Robolab operator; at most the operators are known as laboratory analysts or process analysts, and the responsible manager is known as laboratory manager, quality manager or principal chemist. Some excerpts from the transcription of participants' responses are documented below (Table 4.19):

**Table 4.19 Quotes re technical competencies for a Robolab operator**

Themes	Illustrative Quote
Knowledge of cement process	RO4: The operator in the cement production laboratory need at least basic knowledge of the product produces.
	RO7: The operator need to have basic knowledge of cement process.
Knowledge of chemistry	RO4: It is important to note that the Robolab operator is a laboratory analyst; the laboratory methods and chemistry understanding is paramount to them.
	RO9: Because the operator gives chemical results through the Robolab system, then they need to understand chemistry.
Deal with challenges	RO2: The system has many challenges that the operator must deal with.
Laboratory methodology	RO11: You must have knowledge of laboratory test; it will be good advantage to know how to prepare samples and laboratory solutions.
Care for details	RO1: Have the ability to attentively look, listen and feel any changes in the Robolab.
Work under pressure	RO13: Pressure mount easily during the breakdown, the production does not stop and the operators need results to make quality changes. The operator need to be calm during this time.

To identify the qualifications a Robolab operator should have to inform these competencies, participants were asked to state the required educational qualification that would enhance the competency of a Robolab operator. Their responses are presented in the ATLAS-ti network diagram in Figure 4.3.



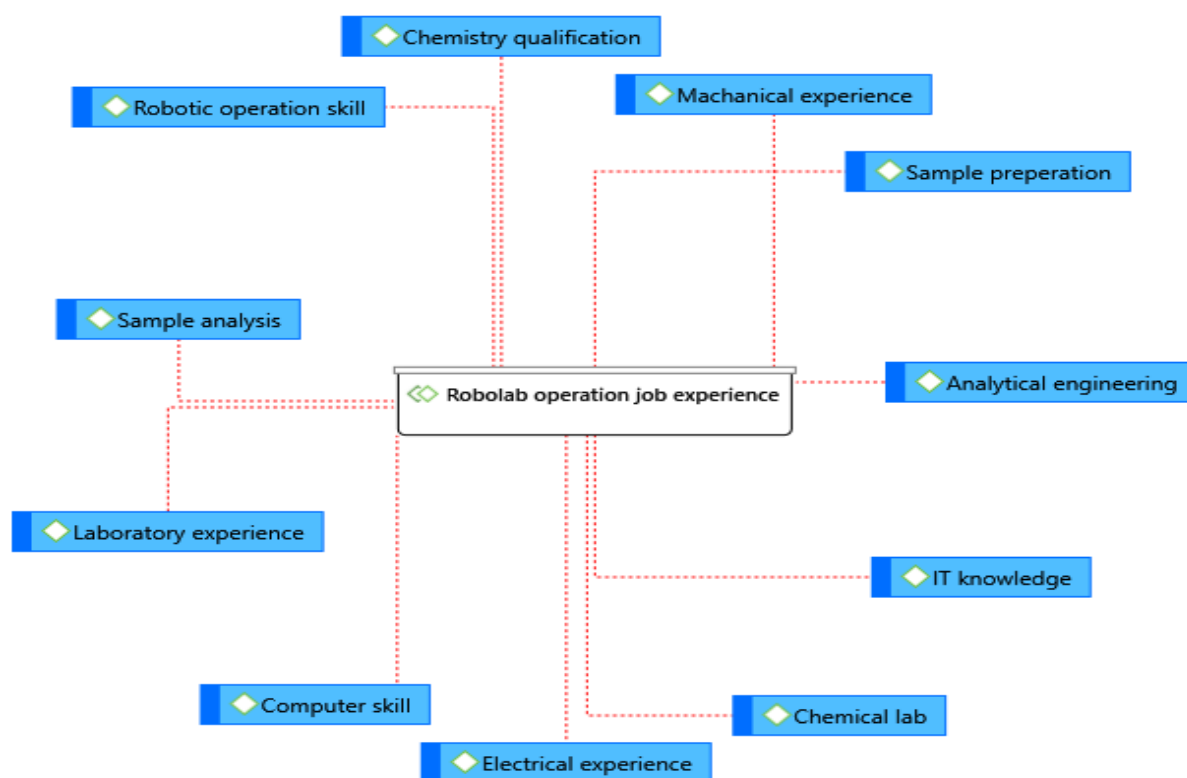
**Figure 4.3 Required educational qualifications of a Robolab operator**

Figure 4.3 presents participants' suggestions about the educational qualifications required for a Robolab operator. Qualifications such as analytical chemistry, chemistry qualification, maths qualification, mechanical qualification, analytical qualification, electrical qualification and science qualification were identified as relevant qualifications for a Robolab operator. Some excerpts from the participants' responses are presented below (Table 4.20):

**Table 4.20 Quotes re educational qualification**

Themes	Illustrative Quote
Science qualification	RO2, RO4, RO5: Maths and science
Analytical chemistry	RO1, RO3: Is of advantage if the Robolab operator have national diploma in analytical chemistry.
	RO2, RO3 and RO4 elaborated that, even though education is important, any person with matric with maths and science can be trained in the laboratory process and be trained to operate the Robolab system.

In a follow-up question, participants were asked to give their views on the required Robolab operation job experience. Their responses are presented in the ATLAS-tinetwork diagram in Figure 4.4.



**Figure 4.4 Required Robolab operation job experience**

Figure 4.4 provides the responses from participants with respect to the job experience required to enhance the operation of a Robolab. Experience of operations such as mechanical experience, sample preparation, analytical engineering, IT knowledge, chemical laboratory, electrical experience, computer skills, sample analysis, laboratory

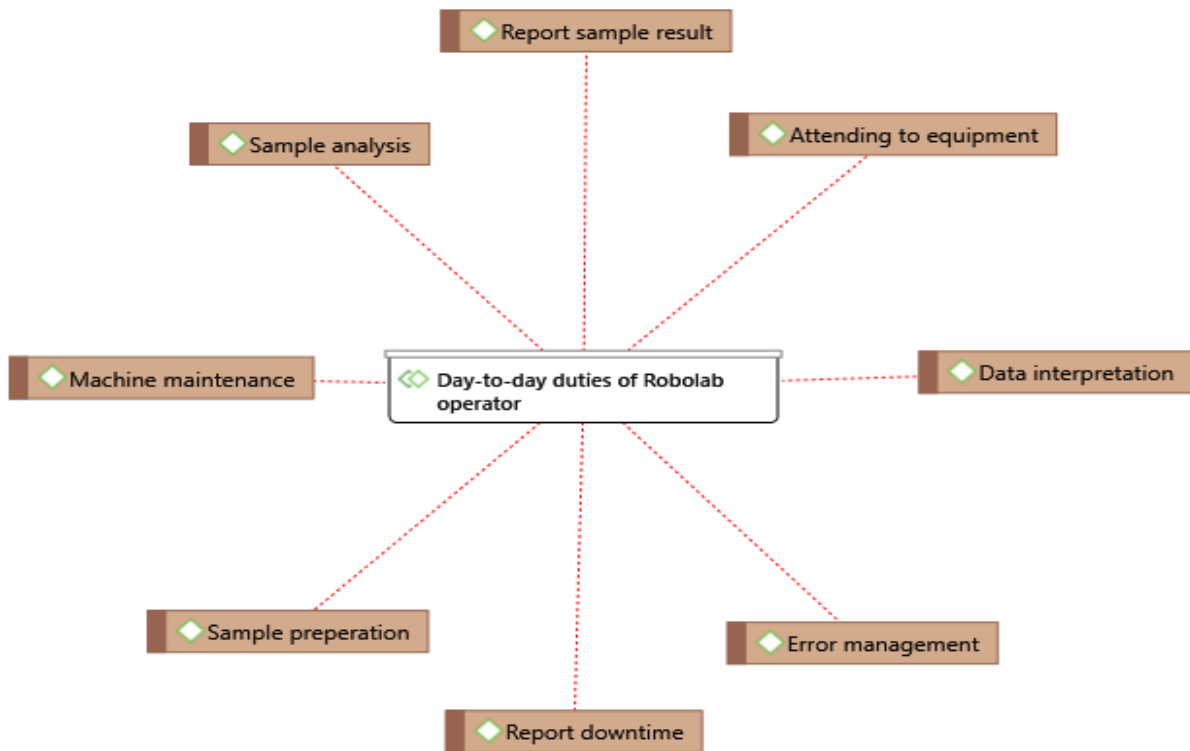
experience, robotic operation skills and chemistry qualification were named as the core job experience for a Robolab operator. Some excerpts from the participants' responses are provided below (Table 4.21):

**Table 4.21 Quotes re operation job experience**

<b>Themes</b>	<b>Illustrative Quote</b>
Computer skills	All participants emphasise the need for the Robolab operator to have computer skills.
Robotic operation skill	RO4: Although this skill is not readily available, it will be advantageous to have the Robotic operation skills.
IT knowledge	RO7: The system is an automated running with IT software; the operator need to have understanding of how the IT system works,
	RO9: The operator must have an understanding of the error codes and the programming of the equipment.
Analytical laboratory	RO8: I did not experience in operating the Robolab, but in our company a person must have experience as a sample processor to get experience in sample preparation and sample analysis.
Sample analysis	RO11: You must have knowledge of laboratory test; it will be good advantage to know how to prepare samples and laboratory solutions.

The participants mentioned that it would be advantageous to get a Robolab operator with experience but the Robolab has new technology, so experience is not readily available. The important factor is getting an operator with the right behavioural competencies, one who is teachable and can be trained to operate the system effectively.

Furthermore, participants were asked to state the day-to-day duties of a Robolab operator to provide information on how Robolab operators' competencies matched with their duties. Their responses are presented in the ATLAS-ti network diagram in Figure 4.5.



**Figure 4.5 Day-to-day duties of a Robolab operator**

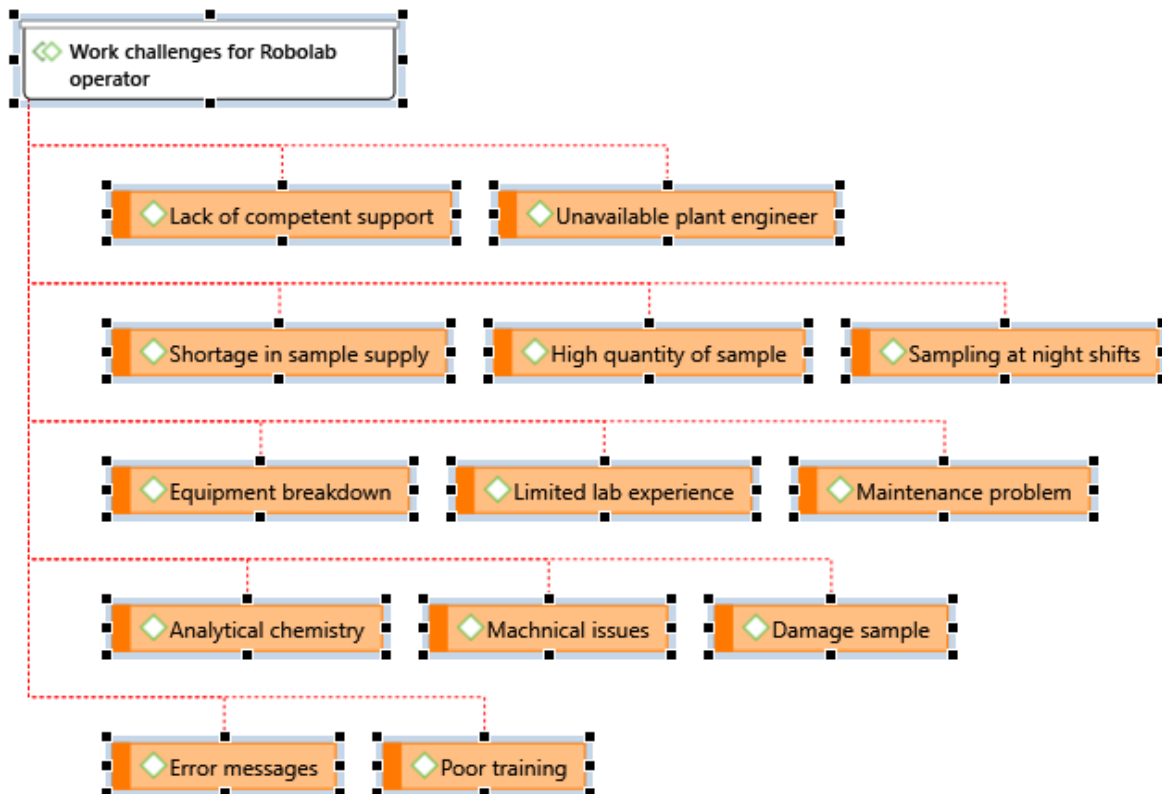
Figure 4.5 provides the views of respondents on the day-to-day duties of a Robolab operator. Duties such as report sample result, attending to equipment, data interpretation, error management, sample analysis, report downtime, sample preparation and machine maintenance were pointed out as major duties of a Robolab operator. Most of the respondents emphasised that they were laboratory analysts by profession, so they needed to be able to sample, prepare and analyse the samples during a system breakdown. Below are some excerpts from the participants' responses (Table 4.22):

**Table 4.22 Quotes re day-to-day duties**

<b>Themes</b>	<b>Illustrative Quote</b>
Sample preparation	RO8 stated that duties such as sampling, preparation and analysis, machine maintenance and data interpretation are the core daily duties of a Robolab operator.
Report downtime	RO8: Any operational breakdown, you have to report them to the supervisor.
Error management	RO1: Operational troubleshooting on the system.
	RO3: Attend to equipment alarms.
Report Results	RO11: Report results to production department and to other internal customers.
Machine Maintenance	Ro12: The operator must be able to do minor maintenance.
Sample analysis	RO12: Because we are analysts by profession, when the system is on the breakdown, you need to analyse the sample manually in the chemical laboratory.

#### **4.4.2 Themes on the Competency Challenges of a Robolab System**

This section of the study examined the participants' understanding of the competency challenges of a Robolab system. This theme is therefore in line with the study objective to identify the gaps and challenges that affect competency profiling in a Robolab system. Participants were asked to state the work challenges for a Robolab operator and their responses are presented in the ATLAS-ti network diagram in Figure 4.6.



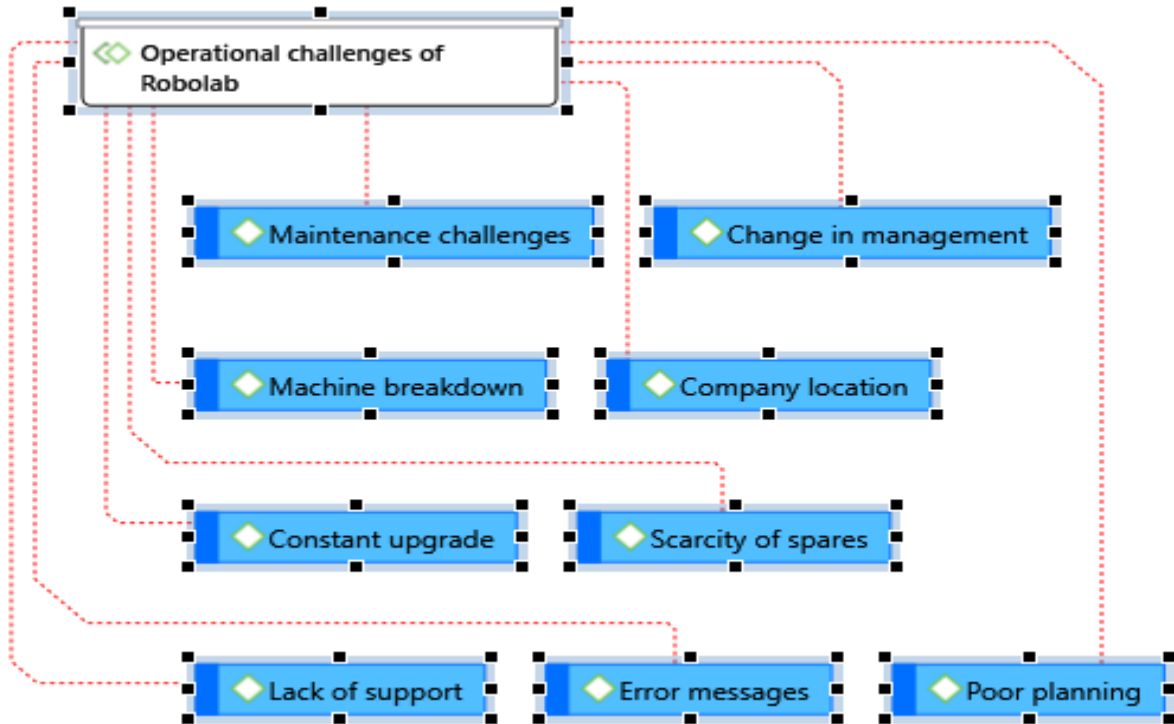
**Figure 4.6 Work challenges for a Robolab operator**

Figure 4.6 provides the views of respondents on the work challenges of a Robolab operator. Some excerpts from participants' responses are provided below (Table 4.23):

**Table 4.23 Quotes regarding work challenges**

<b>Themes</b>	<b>Illustrative Quote</b>
Lack of competent support	RO3: Robolab is a new technology with rare skill to run and maintain the system.
	RO12: Not having competent people to fix and maintain the equipment on site
Poor training:	RO11: The initial training was too short and too fast; we are just doing what we can. It will be best to get a competent Robolab operator to train.
Maintenance problems	RO12: The fact that there is no service plan for the equipment is one big challenge.
	RO10: I do not think there is any service or maintenance plan because always the system is fixed when there is a breakdown.
Mechanical issues	RO11: Mechanical issues and maintenance problem of the system. This equipment can have errors the whole shift, making it difficult to report results on time.
Error messages	RO5: Error, alarms, error and even more errors. The moment I walk onto the laboratory and see red error message, then I know my shift will not be nice at all.
Equipment breakdown	RO9: No engineering personnel dedicated to attending the system errors and breakdowns.
	RO8: Machine breakdown and error message from the robotic machine is my worst nightmares. In addition, the breakdowns: We have no one on-site to attend to our breakdowns fast; everyone is busy on other big plant equipment, and it takes long to fix them.

Participants were asked a follow-up question on the operational challenges of Robolab. Their responses revealed a great number of shortfalls experienced in the operation of Robolab. The responses are presented in the ATLAS-ti network diagram in Figure 4.7.



**Figure 4.7 Operational challenges of a Robolab**

Some excerpts from the comments about the operational challenges of a Robolab are provided below (Table 4.24):

**Table 4.24 Quotes re operational challenges**

<b>Themes</b>	<b>Illustrative Quote</b>
Change management	RO6: Change management. New system need a change in mind and continuous breakdowns of machine slows production down.
Company Location:	RO9: Whenever there is a big breakdown that need the service provider to fix, it takes long because we are in a remote area and the service provider at most need to come from Johannesburg.
	RO10: Sometimes the breakdown takes long because the service provider is too far from us.
Constant upgrades	RO3: The system and software need to be upgraded. When you mention a problem, the supplier will want to sell you an upgrade.
Scarcity of Spares	RO7: Spares for the machine are not readily available
	RO3: The service provider of the system does not keep spares in the country. All spares are orders from overseas and take a good number of weeks to get to the site
Poor Planning	RO10: I will say poor planning because there is always no money to fix the breakdown. The company did not do proper investigation on issues such as efficiency, the cost of operating the system, maintenance planning, and how they will train those who will be operating it. As I mentioned before, I am a laboratory analyst expected to operate the Robolab system.

As a follow-up question, participants were asked if training for Robolab operators is available. Participants' responses are presented in the ATLAS-ti network diagram in Figure 4.8.



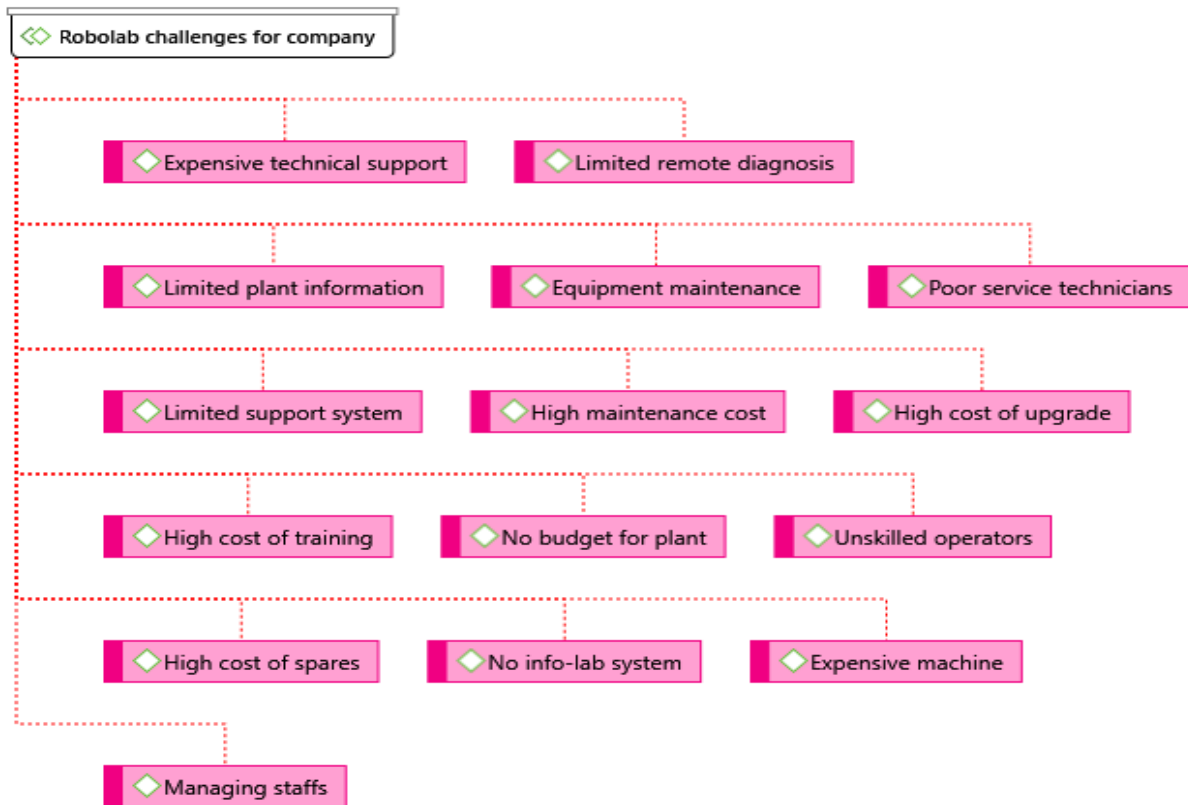
**Figure 4.8 Availability of Training for Robolab Operators**

Figure 4.8 shows that participants indicated training is available from the Robolab service provider. See below some excerpts from the participants' comments (Table 4.25):

**Table 4.25 Quotes regarding availability of training**

Theme	Illustrative Quote
Training is available	RO3: Training modules are available and can be used to better the skill and knowledge of the employees responsible for the day-to-day running of the system, and the training modules are for Robolab operators and the maintenance team.
	RO5: Training modules are available for junior staff mainly; they do basic robotic training. That includes the software and the hardware.
	RO1: Every year the company does organise training. The customers need to enrol for their employees.

Participants were also asked to identify the Robolab challenges for their company. Their responses are presented in the ATLAS-ti network diagram in Figure 4.9.



**Figure 4.9 Robolab challenges for company**

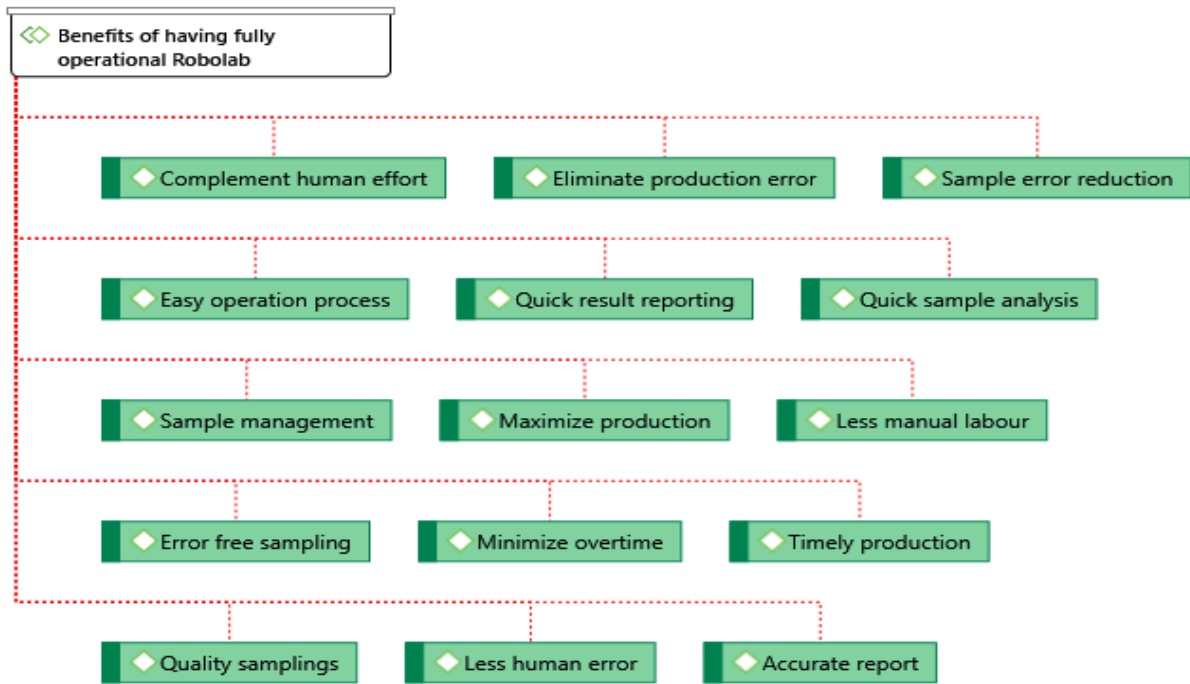
Figure 4.9 presents the participants' answers to the question about Robolab challenges to the company. Challenges such as high cost of upgrade, limited support system, high cost of maintenance, no info-laboratory system, high cost of spares, expensive machine, managing staff, unskilled operators, no budget for plant, high cost of training, limited plant information, equipment maintenance, poor service technicians, expensive technical support and limited remote diagnosis were identified as the major challenges companies encountered with the Robolab system. Some excerpts from the participants' responses are provided below (Table 4.26):

**Table 4.26 Quotes re challenges for the company**

<b>Themes</b>	<b>Illustrative Quote</b>
Expensive technical support:	RO3: We used to pay a lot for the technical support until we decided to appoint an in-house technician.
Limited remote diagnosis	RO4: Lack of remote access for diagnosis is a great challenge, and also system.
High maintenance cost	RO4: System not maintained as per proposed schedule, as well as no budgeting for the post cost of acquiring the Robolab.
Expensive machine:	RO: The system on its own is quite expensive and every service that comes with it is pricy.
Limited plant information	RO5: Modifications can be done and you find that the service provider struggles to maintain the system as they are not aware of that modification.
Unskilled operators	RO6: Customers not having competent operators to run the system.

#### **4.4.3 Themes on the Way Forward for an Effective Robolab System**

This section of the study obtained the participants' opinion on the way forward for an effective Robolab system. This theme is therefore in line with the study's objective to recommend ideas for the competency profiling needs in a Robolab factory. Participants were asked to give their opinion on the benefits of having a fully operational Robolab system. Their responses are presented in the ATLAS-ti network diagram in Figure 4.10.



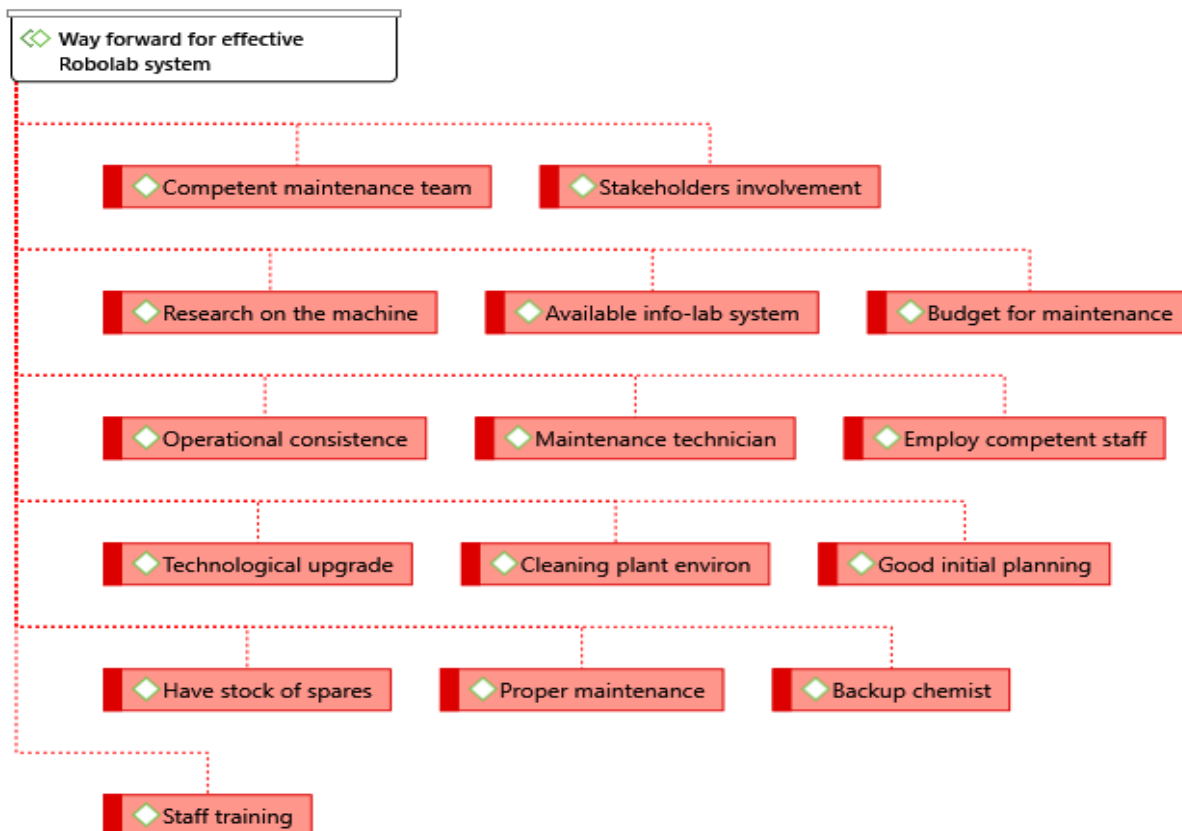
**Figure 4.10** *Benefits of having a fully operational Robolab system*

Figure 4.10 presents participants' views concerning the benefits of having a fully operational Robolab system. Excerpts from their responses are provided below (Table 4.27):

**Table 4.27 Quotes re benefits of a fully operational system**

<b>Themes</b>	<b>Illustrative Quote</b>
Quick results reporting	RO1: The use of Robolab reduce response time (turnaround time) to correct for process quality and increase output of samples.
	RO6: It also help in faster turnaround time of sample results.
Quality sampling	RO2: Robolab helps in improving quality results, quality sample preparation and analysis.
Sample management	RO8: Our section handle a lot of samples and the Robolab can manage them
	RO4: We manage not less than 250 sample per shift. Without the Robolab, we would have to hire a serious number of analysts to handle them manually
Less human error	RO9: It minimize human error
	RO6: Using the Robolab system, helps to reduce human error during sample preparation and analysis.

Finally, participants were asked to suggest a way forward for an effective Robolab system. These suggestions would help to improve the competency profiling of a Robolab factory. Their responses are presented in the ATLAS-ti network diagram in Figure 4.11.



**Figure 4.11 Way Forward for an Effective Robolab System**

Figure 4.11 provides the participants' responses about the way forward for an effective Robolab system. See below some excerpts from their comments (Table 4.28):

**Table 4.28 Quotes re way forward**

<b>Themes</b>	<b>Illustrative Quote</b>
Competent maintenance team	RO1: The use of Robolab reduce response time (turnaround time) to correct for process quality and increase output of samples.
Research on the machine	RO6: It also help in faster turnaround time of sample results
Good initial planning	RO2: The system is a very helpful system, the company need to put measures in place to ensure that the system can continue to run: things like maintenance team, and technicians from the suppliers, and of course all these need finances.
Stock of spares	RO7: Make the parts stock items
Staff training	RO9: I suggest and advise that the company hire a competent person to come and operate the equipment and we as laboratory analyst learn from him/her; maybe like for a period of 6-12 months. I think this will help to develop our skills better on operating the system.
Maintenance technician	RO4: Have dedicated maintenance team for the equipment; it's a robotic system: breakdowns are inevitable
Proper maintenance	RO13: The company must have a good maintenance plan for the equipment and budget enough to service the system.
Budget for Maintenance	RO7: Sufficient budget and good initial plan and support from management.

#### **4.5 Discussion of Findings**

This section of the study presents a discussion of the findings obtained from the empirical part of the study. Such a discussion provides explanations and further interpretation of research results in relation to previous literature on the subject under investigation (Dingwall *et al.*, 2017; McNie *et al.*, 2016).

During the empirical study, a number of themes and categories emerged. This section discusses these themes as they relate to the main research question and the three research sub-questions presented in Chapter 1 of this study.

#### 4.5.1 Main research question

***What are the requisite competencies, to be included in the competency profile that will enhance the professional performance of Robolab operators in a cement production factory?***

This question was included in the study to identify the competencies needed to enhance the operation of a Robolab in a cement production factory. All participants in the study gave their views in this regard, which were documented in Table 4.29.

***Table 4.29 Responses to the main research question***

<b>Themes</b>	<b>Initial Codes</b>	<b>Description</b>
Required behavioural competencies of a Robolab operator.	* Creative and judgement * Care and skilled attitude * Encourage team spirit * Performance-oriented * Truthful * Understanding issues * Give feedback * Good attitude * Championing team * Performance focus * Result-driven * Strategic oriented * Encourage others * Initiate changes * Business-driven * Strategic action * Willing to work * Accountability * Risk reduction * Develop partnership	This theme referred to the behavioural competencies required of a Robolab operator.
Required technical competencies of a Robolab operator.	* Ability to interpret report * Technical confidence * Knowledge in cement process * Adjust to routine schedule * Laboratory methodology * Equipment maintenance * Chemistry knowledge * Ability to communicate * Mechanical knowledge * Equipment assessment * Robotic operation skills * Ability to be attentive * Deal with challenges * Electrical knowledge * Focus * Sample preparation * Process knowledge * Flexible * Attention to details * Knowledge of ISO 9001 * Assertive * Calmness * Innovative * Hand tools * Team worker * Logical sense * Technical skills * Analytical skills * Computer skills * Care for details * Planning ability * Identify patterns * Manage pressure * Willingness to learn	This theme was used to deduce the technical competencies required of a Robolab operator.

Themes	Initial Codes	Description
Required educational qualification of a Robolab operator.	* Analytical chemistry * Chemistry qualification * Maths qualification * Mechanical qualification * Analytical qualification * Electrical qualification * Science qualification	This theme identified the educational qualifications required of a Robolab operator.
Required operational job experience of a Robolab operator.	* Mechanical experience * Sample preparation * Analytical engineering * IT knowledge * Chemical laboratory * Electrical experience * Computer skills * Sample analysis * Laboratory experience * Robotic operation skills * Chemistry qualification	This theme was used to determine the job experience required of a Robolab operator.
Day-to-day duties of a Robolab operator.	* Report sample result * Attending to equipment * Data interpretation * Error management * Sample analysis * Report downtime * Sample preparation * Machine maintenance	This theme referred to participants' understanding of the day-to-day duties of a Robolab operator.

Even though this area of the study found limited instances of previous literature about competency profiling for the Robolab operators in the cement factory, most of the key competencies mentioned by the participants could be sectioned into behavioural, technical, experience and qualifications that enhance these competencies.

The behavioural competencies section contained care and skills attitude, performance-oriented, performance focus, accountability and result-driven, to mention but few. These behavioural competencies are in line with the findings of Gácsi *et al.* (2016); Kock and Weeks (2015) and Tsiakas *et al.* (2018), which indicates that the aforementioned behavioural competencies really do inform effective job performance.

The technical competencies section contained competencies such as ability to interpret analytical data, technical confidence, knowledge in cement process, adjust to routine schedule, laboratory methodology, equipment maintenance, chemistry knowledge, knowledge of ISO 9001, innovative, hand tools knowledge, logical sense, analytical skills, and computer skills, all relevant for the effective and efficient operation

of a Robolab system. Kopacek (2018), Simic and Nedelko (2019) and Tsiakas *et al.* (2018) posit that the technical competencies delineated by the participants are crucial for enhancing mechanised productivity.

The qualifications section contained credentials that would enhance the operational competencies of a Robolab system, such as analytical chemistry, chemistry qualification, maths qualification, mechanical qualification, electrical qualification, and science qualification. It is noted that competencies are underpinned by some level of education, in this regard, Gácsi *et al.* (2016) and Senft *et al.* (2015) argued that, for the efficient operation of a mechanised factory, operators should have some level of technical qualification.

Responses to a follow-up question about the experience a Robolab operator requires indicate that experience such as mechanical experience, sample preparation, analytical engineering, IT knowledge, chemical laboratory, electrical experience, computer skills, sample analysis, laboratory experience and robotic operation skills would optimise the ability of the Robolab operator to effectively operate the System.

The participants emphasised that the skill to operate a Robolab in a cement factory is not readily available in the pool of talent. The employer needs to put in place the training plan that is available from the system's service providers in order to enhance the competency of their employees. In the cement factory and other mineral companies, the Robolab replaces the manual way of sample preparation and sample analysis, and the findings show that it is important for Robolab operators to have good knowledge of chemistry and laboratory operational skills. In fact, a participant mentioned that there was no position known as Robolab Operator; rather, laboratory analysts are trained to use the automated Robolab system to perform their laboratory duties.

Hence, the day-to-day duties of a Robolab operator were aligned with the competencies identified by participants. Duties such as report sample result, attending to equipment, data interpretation, error management, sample analysis, report downtime, sample preparation and machine maintenance were listed as core duties of a Robolab operator, which are mostly the duties of a laboratory analyst.

This section of the study has succeeded in answering the main research question by identifying the competencies needed to enhance the operation of Robolab.

#### **4.5.2 Research sub-question 1**

***What are the requisite technical and behavioural competencies that other companies in South Africa and other countries are using in similar operations?***

In South Africa and other countries, companies that had the Robolab system all stated categorically that laboratory analysts are the personnel who operate the Robolab system: There was no position specifically for a Robolab operator. Incumbents were appointed to work in the laboratory, as either a laboratory analyst or a process analyst, depending on how the company had named the position.

Under behavioural competencies, the participant described them as having a good attitude, assertiveness, being able to work under pressure, paying attention to details, be teachable, be calm and able to deal with challenges, be able to think systematically, be accountable and take responsibility, results focus, customer understanding and passion, and positive minded.

The technical skills that were said to be most needed are those of a laboratory analyst, such as sample preparation, good laboratory practice, ISO 9001, knowledge of chemistry, Computer skills, laboratory information management system(LIMS), Cement chemistry, cement process knowledge, SANS 17025, handle routine work.

Companies with the Robolab system appoint laboratory analysts and take them through training to enable them to operate the Robolab system. There is little expectation that the candidate should have prior experience in the system as it is known that the system is specialised and that there is no readily available skill in the pool of talent.

#### **4.5.3 Research sub-question 2**

***What are the competency gaps and challenges that exist in the Robolab system in the cement factory under study?***

This question was used to identify the gaps and challenges that affect the competency of Robolab operators in a cement factory. Participants gave their opinions regarding this as outlined in Table 4.30.

**Table 4.30 Responses to research sub-question 2**

<b>Themes</b>	<b>Initial Codes</b>	<b>Description</b>
Work challenges faced by a Robolab operator.	* Shortage in sample supply * Lack of competent support * Poor training * Mechanical issues * Damage sample * Maintenance problem * Sampling at night shift * Limited laboratory experience * High quantity of sample * Unavailable plant engineers * Analytical chemistry * Error message * Equipment breakdown	This theme referred to participants' understanding of the work challenges faced by a Robolab operator.
Operational challenges faced by a Robolab operator.	* Lack of support * Constant upgrade * Error messages * Poor planning * Scarcity of spares * Machine breakdown * Company location * Maintenance challenges * Change in management	This theme was used to distinguish the operational challenges faced by a Robolab operator.
Availability of training for a Robolab operator	* Training is available	This theme was used to find out whether training is available for Robolab operators.
Robolab challenges faced by the company.	* High cost of upgrade * Limited support system * High cost of maintenance * No info-laboratory system * High cost of spares * Expensive machine * Managing staffs * Unskilled operators * No budget for plant * High cost of training * Limited plant information * Equipment maintenance * Poor service technicians * Expensive technical support * Limited remote diagnosis	This theme delineated the Robolab challenges faced by the company.

To help identify the competency gap for the Robolab operators in the cement factory, a job profile was obtained (Addendum D). From the job profile, it is clear that the incumbent is classed as a laboratory analyst. Laboratory competencies needed are outlined, but there is no mention of the Robolab tasks, duties and competencies. The laboratory analysts seem to have good knowledge of the laboratory but not of Robolab

operation. This calls for a review of the competency profile and for a training programme to be put in place to ensure that the skill of operating the Robolab can be imparted to the current laboratory analyst.

Both the operators and the company experienced challenges with the Robolab system. The challenges faced by the operators were mostly related to equipment breakdown or downtime due to alarms and equipment failure. Therefore there is a great need to have a dedicated maintenance team on-site to manage these challenges. The respondents emphasised the need for training and a maintenance plan, and the need to have funds available to manage the system and upgrading that are needed for the effective operation of the system. Some of the challenges were referred to as “nightmares” by participants, as they can lead to unproductivity for long hours and frustration of not being able to resolve the issue. The majority of these challenges are peculiar to Robolab system in the cement factory, which demands more mechanical, electrical and IT skills than most laboratory analysts do not have.

The question on operational challenges asked participants to identify technical operational issues that affected the level of competency in the operation of Robolab system. Challenges such as lack of support, need for constant upgrades, error messages, poor planning, unavailability of spares, machine breakdown, company location, maintenance challenges and change in management were pointed out as regular operational issues faced in the operation of Robolab. Responses such as *“Robolab system is a dream sold to companies without realising the greater challenges and financial implication that come with it” (RO3)*, lead one to conclude that operational challenges were not fully investigated before the acquisition of the system. Perhaps the statement *“I do not think that the company has done proper investigation on the system”* is closer to reality. Thus, challenges of this nature greatly affect the operational competency of a mechanised factory (Gácsi *et al.*, 2016).

Although participants indicated that training is available for Robolab operators, it comes at a high cost for the company. *“Everything you ask from the OEM is a cost; you pick the phone and call them for assistance, you pay.”(RO5)* This response makes it clear that the system and its services are pricy due to its specialised technology. The participants mentioned that there are no competent Robolab trainers in the country. The trainers need to fly in from other countries such as Denmark or India, resulting in

more than just training costs – such as flight costs, travelling costs and accommodation.

As per the findings in the literature, that automated equipment comes with more than its fair share of challenges, it is clear that the Robolab system is no different. Among the challenges indicated by participants were high cost of upgrade, limited support system, high cost of maintenance, no info-laboratory system, high cost of spares, expensive machine, managing staff, unskilled operators, no budget for the system, high cost of training, limited system information, equipment maintenance, poor service technicians, expensive technical support and limited remote diagnosis. In essence, any company that has accepted the strengths and advantages of using Robolab should also make provision for managing these challenges.

#### **4.5.4 Research sub-question 3**

##### ***What are the benefits of and recommendations for effective operation of the Robolab system?***

This question sought to ascertain the benefits of an effective and efficient Robolab operating system and the way forward to obtain it. The participants' responses showed many benefits from the adoption of a Robolab system and suggested ways forward for judicious use of the system.

Among the benefits indicated by the participants are eliminate production error, system that complement human effort, easy operation process, quick result reporting, quick sample analysis, sample error reduction, sample management, maximise production, less manual labour, error-free sampling, minimise overtime, timely production, quality sampling, less human error and accurate report.

However, as much as Robolab system provides great benefits, participants agreed with Cooney *et al.* (2018) and Tafazoli and Gómez Parra (2017) that more technical improvements are needed for optimal productivity of a Robolab system. The participants suggested that, among other factors, companies need to improve in the areas of a competent maintenance team, stakeholder involvement, research on the machine, available info-laboratory system, budget for maintenance, operational consistency, maintenance technicians, employing competent staff, technological upgrades, cleaning the plant environment, good initial planning, having stocks of

spares, proper maintenance and staff training. It will serve companies seeking the services of a Robolab system to great advantage if they put enough effort into conducting a proper operational investigation of the system and the cost of having it, and into finding out how those that have it operate it effectively.

#### **4.6 Contribution of the Study**

The contribution of this research can be seen from the outcomes of data analysis. Indeed, the main aim of the research was to fill a gap in the body of knowledge that had not been explored before. Accordingly, the main reason for identifying Robolab competency variables that enhance Robolab operation and productivity was to proffer an academic contribution that could be used to improve competency profiling for the Robolab system within a particular cement factory.

Reflection on the gap in the literature that was identified in Section 2.6 of this study reveals that the interface between the Robolab system structure and the required factory competencies has been neglected. To bridge this gap, this study identified that competency literacy and profiling should be incorporated into the cement company's organisational structure. The contribution of this study is therefore an integrated Robolab competency-profiling model, built from the findings of the empirical analysis. The content of the model should be taken from the core themes for Robolab operational competencies that were suggested to bridge the interface between the Robolab system structure and the required factory competencies. Table 4.31 presents the integrated Robolab competency-profiling model.

**Table 4.31 Integrated Robolab Competency Profiling Model**

<b>Technical Focus</b>	<b>Behavioural Concerns</b>	<b>Professional Traits</b>	<b>Innovation and Creativeness</b>
* Chemical analytical knowledge * Skills in laboratory analysis * Equipment maintenance skills * Robotic operation skills * Electrical knowledge * Knowledge of ISO * Computer skills * Risk reduction skills * IT skills	* Ability to communicate * Ability to interpret documents * Technical confidence * Willingness to learn * Ability to work under pressure * Logical thinking * Accountability * Focus * Creativeness * Team worker	* Sample preparation skill * Results-driven * Feedback * Mechanical qualification * Analytical qualification * Chemistry qualification * Electrical qualification * Robotic error management	* Strategic oriented * Business-driven * Performance-oriented * Innovative * Downtime management * Analytical engineering * Positive change initiatives * Attentiveness to patterns

The Integrated Robolab Competency-Profiling Model presented in Table 4.31 is a coherent combination of extracts from previous literature and the results of empirical data analysis.

It is important to note that individual competencies can only improve the company's productivity when they are developed in line with the company's goals and objectives. The model takes this into consideration when providing a profiling standard that will help bring out the best in the Robolab operators and the entire company management.

The first theme in the model is a technical focus, which should form a standard for pre-recruitment and further development of Robolab operators. Technical skills and knowledge have been identified as crucial factors that enhance operator expertise in a mechanised factory. Under the technical focus, sub-themes such as chemical analytical knowledge, skills in laboratory analysis, equipment maintenance and robotic operation, electrical knowledge, knowledge of ISO 9001, computer skills, risk reduction skills and IT skills should be profiled for effective and efficient Robolab operation.

Behavioural concerns, listed in the second theme, play a great role in optimising Robolab operation. As such, from the onset of an operator's recruitment, companies should take into consideration behavioural attributes like the ability to communicate, ability to interpret documents, technical confidence, willingness to learn, ability to work under pressure, logical thinking, accountability, focus, creativeness and team spirit.

The third theme of the model focuses on the traits that are required for professionalism in Robolab operation. To achieve this professionalism in the cement factory's Robolab operators, it is necessary to maintain the special standards and traits that promote professional traits such as sample preparation skills, result-driven, feedback, mechanical qualification, analytical qualification, chemistry qualification, electrical qualification and robotic error management skills. In the quest to improve professionalism in Robolab operation, concerned management should also encourage operators by providing them with both academic courses and training courses that will enhance their Robolab operational skills.

Competency profiling also helps employees to identify the job-specific positive attributes they possess. Thus, the fourth theme of the model focuses on innovation and creativeness of operators. Sub-themes such as strategic oriented, business-driven, performance-oriented, innovative, downtime management, analytical engineering, positive change initiatives and attentiveness to patterns should be profiled to promote excellence in the Robolab operation in the cement factory. It is believed that incorporating the integrated Robolab competency-profiling model into the Robolab structure of the cement factory will promote professionalism within the organisation.

The company can only succeed in having competent Robolab operators if it puts together a training programme for the operators, and takes note of the recommended way forward for an effective Robolab system.

#### **4.7 Chapter Summary**

This chapter presented the responses obtained from the participants in the empirical study. After interviews were conducted, they were transcribed to enhance the comprehensibility of the data. Furthermore, initial coding was done to highlight the responses of each participant in each context. Themes and categories were generated and the responses were represented in an ATLAS-ti network diagram. Excerpts from

different participants were presented to buttress the points presented in the network diagram. Thereafter, the results from the analysis were discussed in line with the research questions and how they related to previous literature. It was shown that the contribution of the study lay in its provision of a practical, scholarly solution to a real-life situation.

The next chapter focuses on conclusions, discussion of key findings and key policy implications, and recommendations.

# **CHAPTER 5.**

## **CONCLUSION, RECOMMENDATIONS AND SUMMARY**

### **5.1 Introduction**

The aim of this study was to identify the competency profile that, if implemented, will enhance the professional operation of the Robolab system in a specific cement factory. The emphasis was on identifying relevant competency themes and sub-themes that have a significant impact on the operation of a Robolab system. Studies on competency profiling by previous scholars were reviewed and evaluated in Chapter 2. The themes for competency profiling of Robolab operators in the cement factory were identified and grouped into categories to test their effects on the professional operation of the system. Themes and sub-themes that were established as important to the competency profiling of Robolab operators, have been suggested for integration into the organisational structures of companies that use the Robolab system to increase professionalism in their operation.

### **5.2 Conclusion on the Key Findings**

This section of the study presents the key findings of the study, which constitute the empirical evidence to resolve the problem statement it investigated. The key findings of this study are as follows:

- a. Previous literature provided positive theoretical arguments about the importance of competency profiling for Robolab operators in cement factories.
- b. Competencies that were relevant to the operation of Robolab system in a cement factory were identified using standard analytical tools.
- c. Competency profiling was ascertained to be essential for the development of professionalism in the operation of a Robolab in cement production companies.
- d. Behavioural and technical competencies were also identified as a core concern for competency profiling in Robolab factories.
- e. Qualifications in analytical chemistry, electronics, maths, mechanics and science were identified as relevant for Robolab operators.
- f. Experience in analytical engineering, chemical laboratory work and IT were also identified as necessary for Robolab operators.

- g. The Robolab system is normally operated by laboratory analysts in cement factories.
- h. Since the skill to operate the Robolab is not readily available in the talent pool, a proper training plan is essential.
- i. Although the benefits of a Robolab system in a cement production company are enormous, the operational and cost challenges demand careful consideration before acquiring the system.

### **5.3 Managerial Recommendations**

Companies should take into consideration the trend of the fourth industrial revolution for most industrial production processes to adopt a hi-tech medium and strategies for production. It is important to adapt to the trend because previous studies have established that hi-tech and mechanised processes of production and manufacturing enhance professionalism and optimise productivity. Accordingly, profiling the competencies required for Robolab operations becomes inevitable, as core competencies are required for the operation of the robotic machine to maximise productivity. The study was conducted in this context and identified those required competencies, as well as more effective and efficient ways to use a Robolab. The findings of this study recommend the use of the integrated Robolab competency-profiling framework. It is expected that this framework will assist the management of cement production companies that use Robolab systems as well as setting a profiling standard for professionalism in Robolab operation.

### **5.4 Key Managerial Implications**

Managerial implications are outlined to informed key decisions. Management within the cement factories where a Robolab is used should understand the following as it might implicate the effective and efficient operation of the Robolab:

- a. A competent maintenance team should be on standby for any breakdown.
- b. Stakeholder involvement in operations and maintenance issues is advantageous.
- c. Research on the machine will provide operators with better knowledge.
- d. There should be an info-laboratory system available for further diagnosis of machine errors.
- e. Training of the current staff is a key to consistent competency standards.

- f. Technological upgrades, a maintenance plan, available spares, and financial budgeting for the system are key to the effective and efficient operation of Robolab.

## **5.5 Limitations of the Study**

The study of human knowledge and behaviour is a never-ending process. Competency profiling has a wide scope in the field of study, with lots of diverse and, sometimes, complex parts. As such, caution should be exercised when generalising, as some limitations were encountered during the course of this study, as discussed below:

- a. In the quest to have proper representation of informed individuals in the context of this study (Robolab operators), the study sample focused on Robolab systems in cement manufacturing factories. Hence the data was limited to the employees of those cement factories.
- b. Although several competencies that concerned different production companies were identified in the previous studies, this study was limited to competencies required for the effective and efficient operation of a Robolab system in a cement factory.
- c. Previous literature reviewed in this study included studies carried out within and outside South Africa.
- d. The empirical part of this study considered qualitative data from employees of Robolab systems in cement factories not only in South Africa; thus caution should be exercised when making generalisations.
- e. The aim of the study was to propose solutions to long-existing challenges concerning the competency profiling of Robolab operators in cement factories in South Africa. Thus, this study contribution (Integrated Robolab Competency Profiling Model), serves as a management model that could be used to improve professionalism in the operation of Robolab systems in cement factories.

## **5.6 Suggestion for Future Studies**

Research requires a lot of academic commitment. As such, competency profiling for hi-tech and robotic systems incorporates a broad and diverse discipline that not only enhances sound management decision making by stakeholders, but also contributes to the growth of professionalism in Robolab operation. The competency potential of operators contributes to the growth of company productivity, which cushions the

maximisation of production against the costs and challenges of production. Therefore, for continuous improvement and advancement of the concepts of this study, research could be conducted in the following areas in the future:

- Research could be conducted to test the impact of technical and behavioural competencies on the output of the Robolab system in the factory;
- Research could be done to ascertain the differences in output between a robotic cement factory and normal mechanised cement factories;
- Research could be conducted to weigh the benefits against the challenges of Robolab systems in cement factories; and
- An investigation could be conducted to test the practicality of the model (Integrated Robolab Competency Profiling Model) produced in this study.

## **5.7 Summary**

The first chapter of this study provided the introduction to the study, explaining the necessity for Robolab operators to adhere to competency standards. The background to the study, motivation for the study, the problem statement, objectives of the study, research questions, and significance of the study were presented, as well as a brief discussion of research methodology.

Chapter 2 of this study focused on the available literature as it concerns organisational competency profile development and management, as well as the benefits of organisational competency profiling. The review of the literature assisted in conceptualising competency profiling to boost professionalism in Robolab cement factories.

The third chapter dealt with the research methodology used in this study. The research approach and research design were explained and how they fit into the study. An evaluation was done with regard to the target population of the study. In addition, the sampling method and the techniques used for data collection and data analysis were discussed.

The fourth chapter addressed data analysis and the presentation of results. Themes and categories were provided and the responses were represented in ATLAS-ti network diagrams. Excerpts from participant responses were presented and results

were discussed in line with the research questions and how they correlate with previous literature.

This final chapter integrated the conclusions of key findings, recommendations, discussion of key policy implications and the limitations of the study with suggestions for further studies.

## REFERENCES

- Abdulkadiroğlu, A., Angrist, J. D., Narita, Y., & Pathak, P. A. (2017). Research design meets market design: Using centralized assignment for impact evaluation. *Econometrica*, 85(5), pp. 1373–1432.
- Ebrahimi, M., Saives, A.-L. & Holford, W.D. 2008. Qualified ageing workers in the knowledge management process of high-tech businesses. *Journal of Knowledge Management*, 12(2):124-140
- Adedokun, J. A. (2003). *Basics of Research Methodology*. Sagamu: New Hope Publisher.
- Africa, C. (2014). *Production commences at Sephaku Cement's Delmas plant*. Retrieved from: <https://www.cnbc africa.com/news/2014/01/15/production-commences-at-sephaku-cements-delmas-plant/> [Date of access: 15 September 2018.]
- Akinade, E. A., & Owolabi, T. (2009). *Research Methods: A Pragmatic Approach for Social Sciences, Behavioural Sciences and Education*. Lagos: Connel Publications.
- Alpi, K. M., & Evans, J. J. (2019). Distinguishing case study as a research method from case reports as a publication type. *Journal of the Medical Library Association: JMLA*, 107(1):1-5.
- Amrina, E., & Vilsi, A. L. (2015). Key performance indicators for sustainable manufacturing evaluation in cement industry. *Procedia Cirp*, 26, pp. 19–23.
- Angell, C., Alexander, J., & Hunt, J. A. (2015). 'Draw, write and tell': A literature review and methodological development on the 'draw and write' research method. *Journal of Early Childhood Research*, 13(1), pp. 17–28.
- Arunkumar, T., Raj, K., Rufuss, D. D. W., Denkenberger, D., Tingting, G., Xuan, L., & Velraj, R. (2019). A review of efficient high productivity solar stills. *Renewable and Sustainable Energy Reviews*, 101, pp. 197–220.
- Avwokeni, J. A. (2006). *Research Methods: Process, Evaluation & Critique*. Portharcourt: Unicampus Tutorial Services.

- Awoniyi, S. A., Aderanti, R. A., & Tayo, A. S. (2011). *Introduction to Research Methods*. Ibadan: Ababa Press Ltd.
- Baral, N., & Pokharel, M. P. (2017). How sustainability is reflected in the S&P 500 companies' strategic documents. *Organization & Environment*, 30(2), pp. 122–141.
- Basmawi, N. A. H. B., & Usop, H. (2016). The impact of technological change as mediator on employee competency profiling in selected industries in Kuching, Sarawak: A structural equation modeling approach. *Journal of Cognitive Sciences and Human Development*. Vol, 1, p. 2.
- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4), pp. 544–559.
- Benoot, C., Hannes, K., & Bilsen, J. (2016). The use of purposeful sampling in a qualitative evidence synthesis: A worked example on sexual adjustment to a cancer trajectory. *BMC Medical Research Methodology*, 16(1), p. 21.
- Boddy, C. R. (2016). Sample size for qualitative research. *Qualitative Market Research: An International Journal*, 19(4), pp. 426–432.
- Boyatzis, R. E. (1982). *The Competent Manager: A Model for Effective Performance*. Wiley, New York, NY.
- Bresler, L., & Stake, R. E. (2017). Qualitative research methodology in music education. In *Critical Essays in Music Education* (pp.113–128). Routledge.
- Brians, C. L. (2016). *Empirical Political Analysis*. Pearson New International Edition CourseSmart eTextbook. Routledge.
- Burnard, P., Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Analysing and presenting qualitative data. *British Dental Journal*, 204(8), p. 429.
- Chatterjee, S., & Diaconis, P. (2018). The sample size required in importance sampling. *The Annals of Applied Probability*, 28(2), pp. 1099-1135.
- Christofides, P. D., Davis, J. F., El-Farra, N. H., Clark, D., Harris, K. R., & Gipson, J. N. (2007). Smart plant operations: Vision, progress and challenges. *AIChE Journal*, 53(11), pp. 2734–2741.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education*. 7<sup>th</sup> ed: Routledge.

Connelly, L. M. (2016). Trustworthiness in qualitative research. *Medsurg Nursing*, 25(6), pp. 435–437.

Connor, A. M. (2016). An Investigation into the Use of Competency Frameworks for Recruitment and Selection in a Financial Services Organisation in Dublin (Doctoral dissertation, Thesis Submitted to the National College of Ireland, August).

Cooney, M., Yang, C., Padi Siva, A., Arunesh, S., & David, J. (2018). Teaching robotics with robot operating system (ROS): A behavior model perspective. In Workshop on “Teaching Robotics with ROS”, *European Robotics Forum 2018*, Tampere, Finland, March 15, 2018.

Cooper, D. R., & Schindler, P. S. (2003). *Business Research Methods*. International Edition. New Delhi: Tata McGraw- Hill.

Creswell, J. W. (1998). *Qualitative Inquiry and Research Design: Choosing Among Five Traditions*. Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4<sup>th</sup> ed, Sage Publications.

Curnow, C. (2015). *Competency Modeling & Job Analysis*. Retrieved from: <https://home.ubalt.edu/tmitch/651/competency%20modeling%20trendspdf>. [Date of access: 25 October 2015.]

De Vos, A. S., Strydom, H., Fouché, C. B., & Delpont, C. S. L. (2005). *Research at Grassroots for the Social Sciences and Human Service Professions*. Pretoria: Van Schaik.

Dingwall, R., Iphofen, R., Lewis, J., Oates, J., & Emmerich, N. (2017). Towards common principles for social science research ethics: A discussion document for the

Academy of Social Sciences. In *Finding Common Ground: Consensus in Research Ethics Across the Social Sciences* (pp. 111–123). Emerald Publishing Limited.

Draganidis, F., & Mentzas, G. (2006). Competency based management: A review of systems and approaches. *Information Management & Computer Security*, 14(1), pp. 51–64.

Dubois, D. D. (1998). "Preface", *The Competency Casebook: Twelve Studies in Competency-Based Performance Improvement*. Amherst, MA: HRD Press.

Duran, F. F. M., & Mancha-Navarro, T. (2018). The economics sustainability in medium and small companies in Colombia (SMEs). In *Handbook of Research on Intrapreneurship and Organizational Sustainability in SMEs* (pp. 342-367). IGI Global.

Dworkin, S. L. (2012). Sample size policy for qualitative studies using in-depth interviews. *Archives of Sexual Behaviour*, 41(6), pp. 1319–1320.

Eldridge, S. M., Lancaster, G. A., Campbell, M. J., Thabane, L., Hopewell, S., Coleman, C. L., & Bond, C. M. (2016). Defining feasibility and pilot studies in preparation for randomised controlled trials: Development of a conceptual framework. *PLoS one*, 11(3), p.1-22.

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utraiainen, K., & Kyngäs, H. (2014). Qualitative content analysis: A focus on trustworthiness. *SAGE Open*, 4(1), 1-10.

Emami, F. (2017). Application of Competency Management System in Safety Performance: A Case Study of a Canadian Structural Steel and Erection Industry.

Etikan, I., Alkassim, R., & Abubakar, S. (2016). Comparison of snowball sampling and sequential sampling technique. *Biometrics and Biostatistics International Journal*, 3(1), p. 55.

Smidth, F. L. (2016). *What is Quality Control?* Retrieved from: <http://www.flsmidth.com/en-US/Industries/Categories/Products/Laboratory+Solutions/Quality+Control+Software/What+Is+Quality+Control/QCX>. [Date of access: 29 September 2018.]

Friese, S. (2019). *Qualitative data analysis with ATLAS.ti*. SAGE Publications Limited.

Fu, N., Flood, P. C., Bosak, J., Rousseau, D. M., Morris, T., & O'Regan, P. (2017). High-Performance work systems in professional service firms: Examining the practices-resources-uses-performance linkage. *Human Resource Management*, 56(2), pp. 329–352.

Gácsi, M., Kis, A., Faragó, T., Janiak, M., Muszyński, R., & Miklósi, Á. (2016). Humans attribute emotions to a robot that shows simple behavioural patterns borrowed from dog behaviour. *Computers in Human Behavior*, 59, pp. 411–419.

Garavan, T. N., & McGuire, D. (2001). Competencies and workplace learning: some reflections on the rhetoric and the reality. *Journal of Workplace Learning*, 13(4), pp. 144–164.

Gartner Group. (2019). *Building the Right Environment to Improve Quality Staff Competencies*. ID: G00706204. Analyst(s): Quality Research Team. Available at <https://www.gartner.com/en/documents/3913177>.

Gavin, M. (2012). *Plant Engineering*. Retrieved from: <http://www.plantengineering.com/home/single-article/developing-automation-talent/38f0186f36be36dee9e95b7521ec2212.html>. [Date of access: 17 June 2018]

Gervais, J. (2016). The operational definition of competency-based education. *The Journal of Competency-Based Education*, 1(2), pp. 98–106.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British Dental Journal*, 204(6), p. 291.

Gitelman, L. D., Sandler, D. G., Gavrilova, T. B., & Kozhevnikov, M. V. (2018). Complex systems management competency for technology modernization. *International Journal of Design & Nature and Ecodynamics*, 12(4), pp. 525–537.

Gog, M. (2015). Case study research. *International Journal of Sales, Retailing & Marketing*, 4(9).

Grau, A., Indri, M., Bello, L. L., & Sauter, T. (2017), October. Industrial robotics in factory automation: From the early stage to the Internet of Things. *In IECON 2017-*

43rd Annual Conference of the IEEE Industrial Electronics Society (pp. 6159–6164). IEEE.

Gunawan, J. (2015). Ensuring trustworthiness in qualitative research. *Belitung Nursing Journal*, 1(1), pp. 10–11.

Hancock, J., Germano, J., Micciche, D., Murphy, M., & Dolan, D. (2019). System and Method for Determining Competency Deficiencies and Matching Between Particular Projects and Available Workers or Candidates. U.S. Patent Application 16/117,078.

Handayani, P., & Siswoyo, M. (2017), September. Developing learning outcomes to be recognized profession competencies: Case study in Bachelor (D-III) Electronic Technology Study Program. In *International Conference on Technology and Vocational Teachers (ICTVT 2017)*. Atlantis Press.

Hardigan, P. C., Popovici, I., & Carvajal, M. J. (2016). Response rate, response time, and economic costs of survey research: a randomized trial of practicing pharmacists. *Research in Social and Administrative Pharmacy*, 12(1), pp. 141–148.

Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). Case study research: foundations and methodological orientations. In *ed^eds. Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, organised by DEU, p. 17.

Harrisson, A. M. (2019). Constitution and Specification of Portland Cement. In *Lea's Chemistry of Cement and Concrete*, p. 87.

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-based Nursing*, 18(3), pp. 66–67.

Hee Lee, J., & Shvetsova, O. A. (2019). The impact of VR application on student's competency development: A comparative study of regular and VR Engineering classes with similar competency scopes. *Sustainability*, 11(8), p. 2221.

Henriksen, B., Henriksen, J., & Thurston, J. S. (2016). Building health literacy and cultural competency through video recording exercises. *Innovations in Pharmacy*, 7(4).

Heyns, R. (2013). Cement in South Africa. *Kagiso Asset Management Research*, pp. 8–12.

- Hintringer, S. & Nemetz, M., (2011). Process driven competence management: a case study at hilti corporation. In: Maier, R. (Hrsg.), 6th Conference on Professional Knowledge Management – From Knowledge to Action. Bonn: Gesellschaft für Informatik e.V. p. 287-294
- Hoffmann, T. (1999). The meanings of competency. *Journal of European Industrial Training*, 23(6):275–286.
- Indri, M., & Lazzero, I. (2015), September. The RoboLAB experience: Aims, challenges and results of a joint academia-industry laboratory of industrial robotics. In *2015 IEEE 20th Conference on Emerging Technologies & Factory Automation (ETFA)* (pp. 1-8). IEEE.
- Intagliata, J., Ulrich, D., & Smallwood, N. (2000). Leveraging leadership competencies to produce leadership brand: creating distinctiveness by focusing on strategy and results. *Human Resource Planning*, Vol. 23 No. 3, pp. 12–23.
- Jackson, S. E., & Schuler, R. S. (2003). *Managing Human Resources through Strategic Partnerships*, 8th ed., Southwestern, Mason, OH.
- Jalil, D., & Bakar, M. S. A. (2017). Enabling software factory with job workflow automation. *IJCSIS*, 15(4).
- Janani, J., & Gomathi, S. (2015). Formulating and implementing competency modelling, profiling and mapping at Private Limited, Ranipet, Vellore. *Mediterranean Journal of Social Sciences*, 6(1), p. 23.
- Jin, Y., Jing, F., Xuan, Y., Licheng, C., & Meilin, Y. (2018). Research on Deepening Transformation of Automation Talent Training Mode Based on Engineering Application.
- Joshua, C. E. (2016). Towards a culture-oriented e-Learning System Development Framework in higher education institutions in South Africa (Doctoral dissertation, North West University).
- Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, 72(12), pp. 2954–2965.

Kannan, D., Govindan, K., & Rajendran, S. (2015). Fuzzy Axiomatic Design approach based green supplier selection: A case study from Singapore. *Journal of Cleaner Production*, 96, pp. 194–208.

Karabegović, I., Karabegović, E., Mahmić, M., & Husak, E. (2015). The application of service robots for logistics in manufacturing processes. *Advances in Production Engineering & Management*, 10(4).

Kassem, M., Raoff, A., Liyana, N., & Ouahrani, D. (2018). Identifying and analyzing BIM specialist roles using a competency-based approach: Creative Construction Conference 2018, CCC 2018, 30 June - 3 July 2018, Ljubljana, Slovenia. <http://nrl.northumbria.ac.uk/34637/>. [Date access 20 November 2019] .

Kock, T., & Weeks, W. (2015). Job-related competencies desired by those who hire international development consultants. *Journal of International Agriculture and Extension Education*, 22(1), pp. 21–34.

Koh, E. H., Avvari, M. V., & Tan, K. H. (2016). An integrated framework for competency development: perspectives of risk managers in banks. *Service Business*, 10(3), pp. 581–602.

Kooiman, T. J., Dontje, M. L., Sprenger, S. R., Krijnen, W. P., van der Schans, C.P., & de Groot, M. (2015). Reliability and validity of ten consumer activity trackers. *BMC Sports Science, Medicine and Rehabilitation*, 7(1), p. 24.

Kopacek, P. (2018). Development trends in cost oriented production automation. *IFAC-PapersOnLine*, 51(30), pp. 39-43.

LeBoterf, G. (1998). Evaluer les compétences, quels jugements? Quels critères? Quelles instances? *La Compétence au Travail*, 135(2), pp. 143–151.

Leedy, P. D., & Ormrod J. E. (2010). *Practical Research. Planning and Design*. 9th edition. Upper Saddle River, New Jersey. Pearson.

Leitner, M. L., & Strauss, C. 2008. Exploratory case study research on web accessibility. International Conference on Computers for Handicapped Persons, organised by Springer. p. 490–497.

- Lewin, S., Glenton, C., Munthe-Kaas, H., Carlsen, B., Colvin, C. J., Gülmezoglu, M., Noyes, J., Booth, A., Garside, R., & Rashidian, A. (2015). Using qualitative evidence in decision making for health and social interventions: An approach to assess confidence in findings from qualitative evidence syntheses (GRADE-CERQual). *PLoS medicine*, 12(10), p.1-18.
- Lewis, S. (2015). Qualitative inquiry and research design: Choosing among five approaches. *Health Promotion Practice*, 16(4), pp. 473–475.
- Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2011). Paradigmatic controversies, contradictions, and emerging confluences revisited. In N. K. Denzin & Y. S. Lincoln, *The SAGE Handbook of Qualitative Research*, 4th ed. (pp. 97–128). Thousand Oaks, CA: Sage.
- Liu, H., Wei, S., Ke, W., Wei, K. K. & Hua, Z. (2016). The configuration between supply chain integration and information technology competency: A resource orchestration perspective. *Journal of Operations Management*, 44, pp. 13–29.
- Longo, F., Nicoletti, L., & Padovano, A. (2017). Smart operators in industry 4.0: A human-centered approach to enhance operators' capabilities and competencies within the new smart factory context. *Computers & Industrial Engineering*, 113, pp. 144–159.
- Maree, K. (2015). *First steps in research*. Pretoria: Van Schaik Publishers.
- Marrelli, A. F. (1998). An introduction to competency analysis and modeling. *Performance Improvement*, 37, pp. 8–17.
- Mathur, M., & Hameed, S. (2016), September. A study on behavioural competencies of the Z generation. In *International Conference on Management and Information Systems* (pp. 63–71).
- McClelland, D. C. (1973). Testing for competence rather than for “intelligence”. *American Psychologist*, 28(1), p. 1-14.
- McNie, E. C., Parris, A., & Sarewitz, D. (2016). Improving the public value of science: A typology to inform discussion, design and implementation of research. *Research Policy*, 45(4), pp. 884–895.

- Mills, J., Harrison, H., Franklin, R., & Birks, M. (2017). Case study research: Foundations and methodological orientations. In *eds. Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, organised by DEU. (p. 17).
- Mitra, S., Bangia, S., & Mitra, J. (2008). *18 Management Competencies Business Professionals Cannot Ignore*. New Delhi: Sterling Publishers.
- Moore, D. R., Cheng, M. I., & Dainty, A. R. J. (2002). Competence, competency and competencies: performance assessment in organisations. *Work Study*, 51(6), pp. 314–319.
- Morse, J. M. (1994). Designing funded qualitative research. In N. K. Denzin, & Y. S. Lincoln, *Handbook of Qualitative Research*, 2nd ed. Thousand Oaks, CA: Sage.
- Moustroufas, E., Stamelos, I., & Angelis, L. (2015). Competency profiling for software engineers: Literature review and a new model. In *Proceedings of the 19th Panhellenic Conference on Informatics* (pp. 235–240). ACM.
- News, G. C. (2014). Sephaku Cement set to produce clinker at Aganang plant. Retrieved from: <http://www.globalcement.com/news/item/2815-sephaku-cement-set-to-produce-clinker-at-aganang-plant>. [Date of access: 15 September 2018.]
- Nilson, S., & Ellström, P. E. (2012). Employability and talent management: Challenges for HRD practices. *European Journal of Training and Development*, 36(1), pp. 26-45.
- Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence-based Nursing*, 18(2), pp. 34–35.
- Noe, R. A., Hollenbeck, J. R., Gerhart, B., & Wright, P. M. (2017). *Human Resource Management: Gaining a Competitive Advantage*. New York, NY: McGraw-Hill Education.
- Oates, B. J. (2008). *Researching Information Systems and Computing*. London: SAGE Publications.
- Obeidat, B. Y., Al-Dmour, R. H., & Tarhini, A. (2015). Knowledge management strategies as intermediary variables between itbusiness strategic alignment and firm performance. *European Scientific Journal*, 11(7).

Palys, T. (2008). *Purposive sampling*. The Sage Encyclopaedia of Qualitative Research Methods, 2, pp. 697–698.

Perrenaud, P. (2000). *10 Novas competencias para ensinar*, ArtMed Editora. Portoalegre.

Pickett, J., Cullen, F., Bushway, S. D., Chiricos, T., & Alpert, G. (2018). The response rate test: Nonresponse bias and the future of survey research in criminology and criminal justice. Available at: SSRN 3103018.

Podmetina, D., Soderquist, K. E., Petraite, M., & Teplov, R. (2018). Developing a competency model for open innovation: From the individual to the organisational level. *Management Decision*, 56(6), pp. 1306–1335.

Prikshat, V., Kumar, S., Nankervis, A., & Khan, M. M. S. (2018). Indian HR competency modelling: profiling, mapping and an investigation of HRM roles and competencies. *The Journal of Developing Areas*, 52(4), pp. 269–282.

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management*, 8(3), pp. 238–264.

Quick, J., & Hall, S. (2015). Part two: Qualitative research. *Journal of Perioperative Practice*, 25(7–8), pp. 129–133.

Ravitch, S. M., & Riggan, M. (2012). *Reason & Rigor: How Conceptual Frameworks Guide Research*. Thousand Oaks CA: Sage Publications.

Rios, A., Alvarez, L., & Adams, K. (2017). Robotic systems for augmentative manipulation to promote cognitive development, play, and education. In *Robotic Assistive Technologies* (pp. 219–261). CRC Press.

Robinson, K. A., Akinyede, O., Dutta, T., Sawin, V. I., Li, T., Spencer, M. R., Turkelson, C. M., & Weston, C. (2013). Framework for determining research gaps during systematic review: evaluation.

Robinson, K. A., Saldanha, I. J., & Mckoy, N. A. (2011). Frameworks for determining research gaps during systematic reviews.

- Rondon, M. H. D. F., & Fontes, R. S. (2017). Reflections on automation and the need for new competencies in the civil pilot training. *Aeron Aero Open Access J*, 1(4), p. 00019.
- Rosenthal, E. (2007). Cement industry is at centre of climate change debate. *New York Times*, 26, p. 24.
- Rowbotham, N., Smith, S., Robinson, K., & Smyth, A. (2016). Gaps in the evidence for treatment decisions in Cystic Fibrosis: A systematic review.
- Sailer, M., Hense, J., Mandl, H., & Klevers, M. (2017). Fostering development of work competencies and motivation via gamification. In *Competence-based Vocational and Professional Education* (pp. 795–818). Springer, Cham.
- Sanghi, S. (2016). *The Handbook of Competency Mapping: Understanding, Designing and Implementing Competency Models in Organizations*. SAGE Publications India.
- Sarma, S. K. (2015). Qualitative Research: Examining the Misconceptions. *South Asian Journal of Management*, 22(3), pp. 176–191.
- Saunders, M. N., Lewis, P., & Thornhill, P. (2009). *Research Methods for Business Students*. Pearson Education, 5th edition. ISBN 978-0-273-71686-0.
- Scrivener, K. L., John, V. M., & Gartner, E. M. (2016). Eco-efficient cements: Potential economically viable solutions for a low-CO<sub>2</sub> cement-based materials industry.
- Sekaran, U., & Bougie, R. (2016). *Research Methods for Business: A Skill Building Approach*. John Wiley & Sons.
- Selby, S. C., Roos, I., & Wright, L. (2000). Investigation of the application of frontline management training in the community services and health industry: a progress report. Paper presented at the Victorian Community Services and Health Industry Training Board Conference, Melbourne, 22 June. *Fundamentals and New Directions in Sample Preparation*. Vol. 37: Elsevier.
- Senft, E., Baxter, P., Kennedy, J., & Belpaeme, T. (2015), October. Sparc: Supervised progressively autonomous robot competencies. In *International Conference on Social Robotics* (pp. 603–612). Springer, Cham.

- Sengupta, A., Venkatesh, D. N., & K. Sinha, A. (2013). Developing performance-linked competency model: a tool for competitive advantage. *International Journal of Organizational Analysis*, 21(4), pp. 504-527.
- Shafeek, H. (2014). Continuous improvement of maintenance process for the cement industry: A case study. *Journal of Quality in Maintenance Engineering*, 20(4), pp. 333-376.
- Shah, C. R. (2016). Competency Mapping and its impact on Organization Effectiveness with special reference to Sales Staff of Pharmaceutical Industry of Ahmedabad Region. Ahmedabad, India: Gujarat Technological University.
- Shellabear, S. (2002). Competency profiling: Definition and implementation. *Training Journal-Ely-*, pp. 16–19.
- Shields, P. M., & Rangarajan, N. (2013). *A Playbook for Research Methods: Integrating Conceptual Frameworks and Project Management*. New Forums Press.
- Shippmann, J. S., Ash, R. A., Batjtsta, M., Carr, L., Eyde, L. D., Hesketh, B., Kehoe, J., Pearlman, K., Prien, E. P., & Sanchez, J. I. (2000). The practice of competency modeling. *Personnel Psychology*, 53(3), pp. 703–740.
- Simic, M., & Nedelko, Z. (2019). Development of Competence Model for Industry 4.0: A Theoretical Approach. Economic and Social Development: *Book of Proceedings*, pp. 1288–1298.
- Smith, J., & Firth, J. (2011). Qualitative data analysis: the framework approach. *Nurse Researcher*, 18(2), pp. 52–62.
- Srividya, N., & Basu, R. (2015). Competency Mapping Correctional Officers. *SCMS Journal of Indian Management*, 12(1).
- Stemler, S. E. (2015). *Content analysis*. Emerging trends in the social and behavioral sciences: An Interdisciplinary, Searchable, and Linkable Resource, pp. 1–14.
- Stepanenko, V., & Kashevnik, A. (2017), April. Competence management systems in organisations: A literature review. In *2017 20th Conference of Open Innovations Association (FRUCT)* (pp. 427–433). IEEE.

- Stuckey, H. L. (2015). The second step in data analysis: Coding qualitative research data. *Journal of Social Health and Diabetes*, 3(01), pp. 007–010.
- Tafazoli, D., & Gómez Parra, M. E. (2017). Robot-assisted language learning: Artificial intelligence in second language acquisition. *Current and Future Developments in Artificial Intelligence*, 370.
- Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a qualitative research approach. *Journal of Graduate Medical Education*, 7(4), pp. 669–670.
- Tetnowski, J. (2015). Qualitative case study research design. *Perspectives on Fluency and Fluency Disorders*, 25(1), pp. 39-45.
- The UK National (and Scottish) Vocational Qualification System. 1997. State of the art or in a state? *International Journal of Training and Development*, 1(4), p. 242.
- Thinnisses, P., Boselie, P., & Fruytier, B. (2013). A review of talent management: 'infancy of adolescence?' *International Journal of Human Resource Management*, 24(9), pp. 1744–1761.
- Thomas, G. (2011). *How To Do Your Case Study: A Guide for Students and Researchers*. Los Angeles, Calif. SAGE.
- Thunnissen, M., Boselie, P., & Fruytier, B. (2013). A review of talent management: 'infancy or adolescence?'. *The International Journal of Human Resource Management*, 24(9), pp. 1744-1761.
- Tong, A., & Dew, M. A. (2016). Qualitative research in transplantation: Ensuring relevance and rigor. *Transplantation*, 100(4), pp. 710-712.
- Treasury Board of Canada Secretariat. (1999). *Framework for Competency-based Management in the Public Service of Canada*. Report of joint initiative between the Treasury Board of Canada Secretariat and the Public Service Commission, December.
- Tsiakas, K., Kyrarini, M., Karkaletsis, V., Makedon, F., & Korn, O. (2018). A Taxonomy in Robot-Assisted Training: Current Trends, Needs and Challenges. *Technologies*, 6(4), p. 119.

- Ungerer, L. M. (2016). Digital curation as a core competency in current learning and literacy: A higher education perspective. *The International Review of Research in Open and Distributed Learning*, 17(5).
- Uzzaman, I., Rahman, M., Alam, M., & Alam, S. (2016). Simulation of cement manufacturing process and demand forecasting of cement industry. *Global Journal of Researches in Engineering: G Industrial Engineering*, 16(2).
- Vaiman, V., Scullion, H., & Collings, D. (2012). Talent management decision making. *Management Decision*, 50(5), pp. 925–941.
- Vakola, M., Eric Soderquist, K., & Prastacos, G. P. (2007). Competency management in support of organisational change. *International Journal of Manpower*, 28(3/4), pp. 260–275.
- Van Vuuren, D. P., Stehfest, E., Gernaat, D. E., Berg, M., Bijl, D. L., Boer, H. S., Daioglou, V., Doelman, J. C., Edelenbosch, O. Y., Harmsen, M., & Hof, A. F. (2018). Alternative pathways to the 1.5 C target reduce the need for negative emission technologies. *Nature Climate Change*, 8(5), p. 391.
- Verner, J. M., & Abdullah, L. M. (2012). Exploratory case study research: Outsourced project failure. *Information and Software Technology*, 54(8), pp. 866–886.
- Visvanathan, K., Levit, L. A., Raghavan, D., Hudis, C. A., Wong, S., Dueck, A., & Lyman, G. H. (2017). Untapped potential of observational research to inform clinical decision making: American Society of Clinical Oncology Research Statement. *Journal of Clinical Oncology*, 35(16), pp. 1845–1854.
- Vladova, G., Ullrich, A., & Sultanow, E. (2017). Demand-oriented competency development in a manufacturing context: the relevance of process and knowledge modeling: Proceedings of the 50th Hawaii International Conference on System Sciences 2017. <http://hdl.handle.net/10125/41699> . [date access 20 November 2019]
- Vlok, A. (2017). A competency profile for technology innovation leaders in knowledge-intensive organisations in South Africa (Doctoral dissertation, Stellenbosch: Stellenbosch University).

- Walker, F., Link, N., & Nickolaus, R. (2016). A multidimensional structure of domain-specific problem-solving competencies of electronics technicians for automation technology. *Empirical Research in Vocational Education and Training*, 8(1), p. 7.
- Waller, V., Farquharson, K., & Dempsey, D. (2015). *Qualitative Social Research: Contemporary Methods for the Digital Age*. Sage. ISBN 978-1-4462-5883-5.
- Wayne, I., & Simpson, S. (2013). The Competency-Based Management Blog. Retrieved from <http://blog.competencycore.com/2013/04/competencyframework.html>. [Date of access: 29 September 2018.]
- Whelan, E., Collings, D. G., & Donnellan, B. (2010). Managing talent in knowledge-intensive settings. *Journal of Knowledge Management*, 14(3), pp. 486–504.
- Wildemuth, B. M. (2016). *Applications of Social Research Methods to Questions in Information and Library Science*. ABC-CLIO.
- Woessmann, L. (2016). The economic case for education. *Education Economics*, 24(1), pp. 3–32.
- Yigitcanlar, T., & Bulu, M. (2015). Dubaization of Istanbul: Insights from the knowledge-based urban development journey of an emerging local economy. *Environment and Planning A*, 47(1), pp. 89–107.
- Yin, R. K. (2009). *Case Study Research Design and Methods*. 4th edition. Los Angeles, Calif.: Sage Publications.
- Yin, R. K. (2014). *Case Study Research: Design and Methods*. 5<sup>th</sup> edition. SAGE.
- Yuvaraj, R. (2011). Competency mapping. *International Journal of Scientific & Engineering Research*, 2(8), pp. 1-7.
- Zainal, Z. (2007). Case study as a research method. *Jurnal Kemanusiaan*, 5(1).

# ADDENDUMS

## Addendum A: Ethical clearance certificate



Private Bag X6001, Potchefstroom  
South Africa 2520

Tel: 018 299-1111/2222  
Web: <http://www.nwu.ac.za>

18 June 2019

*Per e-mail*

Dear A Manganye,

### **FEEDBACK POST FACTO: ETHICS APPLICATION 18062019: A Manganye (26870940) (NWU-00172-16-A9) MBA**

Your ethics application on, *A competency profile and implementation plan of Robolab operators in a cement factory* that served on the Post Facto meeting of 18 June 2019 refers.

#### **Outcome:**

Extension is hereby granted, to continue using A number **NWU-00172-16-A9**, to enable the researcher to complete the study. (The given number expired 7/3/2019.)

Kind regards,



Prof Jan Meyer  
Chairperson: Post Facto Ethics  
FEMS

**Addendum B: Permission for conducting the research**



10/04/2019

To whom it may concern

Sephaku cement is mining company compiled with two division in South Africa – Aganang and Delmas plants.

I hereby authorise Annah Manganye to conduct her research study at Sephaku cement and I will appreciate after the research to be given the outcomes.

Regards,

  
Sam Mkwanzazi

OP Manager

Dangote Cement South Africa (Pty) Limited  
Via Sephaku Cement  
Reg No: 2004/034277/07  
T: +27 (0) 12 684 6300  
F: +27 (0) 12 684 6301

Ground Floor, Block A  
Southdowns Office Park  
Cnr John Vorster Dr & Karee St  
Irene X54, 0062  
PO Box 68149, Highveld 0169

A. Dangote# (Chairman), P.F. Fourie (CEO), J.O. Makoju# (Director)  
S.O. Olarinde# (Financial Director), M.O. Alake#, D.V.G. Edwin\*\*  
A.S. Mahmoud#\*, R.S. Ntuli\*, Dr L. Mohuba, N.R. Crafford-Lazarus

#Nigerian, \*\*Indian, \*Independent Non-Executive Director

[www.sephakucement.co.za](http://www.sephakucement.co.za)

## Addendum C: Interview guide

RESEARCH BY ANNAH MANGANYE

	<p><b>Interview Guide</b></p> <p><b>Dear Participant</b></p> <p><b>I am Annah Manganye, a registered MBA student at the NWU Business School, and need your input as a Robolab operator. You are kindly requested to participate in an interview with me, which should not take more than 40 minutes. I am going to take notes and make a recording during the interview to ensure I capture all the required information.</b></p> <p><b>Your valuable inputs would be highly appreciated and you can withdraw at any time.</b></p> <p><b>My MBA research study is on “The development of a competency profile and implementation plan for Robolab operators in a cement factory “</b></p> <p>By taking part in this study you have provided your consent.</p> <p>Instructions to Participants:</p> <p><b>First I need a few demographic inputs from you, which will be anonymous. This is needed for the descriptive part of the study. Thereafter I will engage you on specific Robolab questions.</b></p>	
	<b>SECTION A: PERSONAL DETAILS</b>	
	Please tick in the box to indicate your response	
1)	Age (in years): <input type="checkbox"/> Less than 25 <input type="checkbox"/> 25–30 <input type="checkbox"/> 31 – 35 <input type="checkbox"/> 36–40 <input type="checkbox"/> 41- 50 <input type="checkbox"/> More than 50	

2)	Gender: <input type="checkbox"/> Male <input type="checkbox"/> Female
3)	Education: <input type="checkbox"/> Undergraduate Diploma <input type="checkbox"/> Bachelor's Degree <input type="checkbox"/> Master's Degree <input type="checkbox"/> Doctoral Degree <input type="checkbox"/> If others, please specify _____
4)	Work Experience in Robolab ( in years) <input type="checkbox"/> Less than 5 <input type="checkbox"/> <b>5 – 10</b> <input type="checkbox"/> 11–15 <input type="checkbox"/> 16 – 20 <input type="checkbox"/> More than 20 years
5)	Nationality <input type="checkbox"/> South African <input type="checkbox"/> Other –Specify _____

<b>B. Robolab Questions</b>		
<b>What are your major duties as the Robolab operator?</b>		
<b>What are the day-to-day duties/responsibilities of a Robolab operator?</b>	<b>Key performance area</b>	
<b>Before this position what job experience did you have</b>		
<b>Did you receive adequate training to operate the Robolab system</b>		
	<b>The Skills needed</b>	<b>The Knowledge needed</b>

<b>What are the technical competencies do you have as a Robolab operator?</b>		
<b>The Abilities needed</b>		
<b>Can you please outline your behavioural competencies as a Robolab operator</b>	<b>Their Attitude</b>	<b>Personality traits</b>
	<b>Motivation</b>	<b>Self-concept</b>
<b>Interests</b>	<b>Beliefs</b>	<b>Values</b>
<b>What are the work challenges that as a</b>		

<p><b>Robolab operator you face?</b></p>	
<p><b>What are the general challenges that your organization is facing with regard to a Robolab system</b></p>	
<p><b>In your opinion what are the benefit for having a fully working Robolab System</b></p>	
<p><b>In your opinion why did your company acquire the Robolab system?</b></p>	
<p><b>Was your company aware of all the important facts such as maintenance</b></p>	

<b>plan, skills, availability of parts, running cost when acquiring the Robolab?</b>	
<b>Was your company ready to use the Robolab from day 1 of its operation? How did you manage this?</b>	
<b>Is there anything else you can add about the Robolab functioning efficiently and effectively?</b>	

**THANK YOU VERY MUCH FOR YOUR PARTICIPATION**

## Addendum D: Job Profile for Laboratory analyst

### Job Profile

#### 1. JOB DETAILS

Job Title	Laboratory Analyst	Grade	TBD
Organisational Unit	Aganang		
Department	Quality		
Line Manager	Chemist		
Date last reviewed	03 October 2018	Author	

#### 2. OUTPUT PROFILE

<b>2.1 Purpose</b>	
To conduct sampling and chemical analysis on various materials in the laboratory through adherence to laboratory standards, policies and procedures and to report the results produced.	
<b>2.2 Reports</b>	
Direct Reports	None
Indirect Reports	None

<b>2.3 Job Outputs</b>	
Key Performance Area	Performance Outputs
1. Carry out work routine against set targets	<ul style="list-style-type: none"> <li>Carry out appropriate sampling of all relevant materials</li> <li>Carry out required testing in accordance with stated test methods and testing schedule</li> <li>Adhere to specific testing procedures with thought deviation</li> <li>Analysing results, able to interpret them and report to immediate superior for corrective action</li> <li>Ensure accurate and consistent testing of the samples</li> <li>Keep good housekeeping</li> <li>Carry out all test and report according to ISO 9001</li> <li>Analyse the check or relevant reference material for tests and analytical equipment</li> </ul>
2. Reporting	<ul style="list-style-type: none"> <li>Accurately report analytical results</li> <li>Reporting of results on QMS and on all relevant reports</li> <li>Ensure traceability of results by making use of standard forms or specified method</li> <li>Report all non-conformances in accordance to the specified rules</li> </ul>
3. Equipment	<ul style="list-style-type: none"> <li>Verify the equipment by use of internal reference, check standard or certified reference material and maintain the equipment in accordance</li> </ul>

## Job Profile

2.3 Job Outputs	
Key Performance Area	Performance Outputs
	<p>with schedule to ensure accuracy of testing equipment and meet availability performance target</p> <ul style="list-style-type: none"> <li>• Report any equipment breakdown</li> <li>• Ensure that the verification equipment are calibrated and that calibration is still valid</li> </ul>
4. Manage turnaround time	<ul style="list-style-type: none"> <li>• Ensure all sampling is done at the specified times</li> <li>• Ensure that results are reported on time without delay to the production operators</li> </ul>
5. Internal and External customers	<p>Maintain customer loyalty and continuous improvement realization</p> <ul style="list-style-type: none"> <li>• Build inter customer relations through effective communication</li> <li>• Prevent sample contaminations</li> <li>• Achieve turnaround times by ensuring that results are reported on time</li> <li>• Immediately report any quality deviations or equipment failure to the Chemist or Quality manager to ensure that effective actions</li> </ul>
6. Safe laboratory:	<ul style="list-style-type: none"> <li>• Adhere to applicable legislations</li> <li>• Adhere to Safety standards</li> <li>• Proactively promoted safe behaviour</li> <li>• Report on incidents and accidents against set standard</li> <li>• Support safety initiatives from the Risk and safety department</li> </ul>
7. Cost forecast achieved	<ul style="list-style-type: none"> <li>• No wastages</li> <li>• Manage your absences</li> </ul>
8. Teamwork and engagement	<ul style="list-style-type: none"> <li>• Participate in regular team meetings to review targets against KPI's;</li> <li>• Relevant information is shared and discussed with Verification Analyst and team members;</li> <li>• Maintain co-operative relationships with supporting functions by supporting cross-functional teams for problem-solving;</li> <li>• Employee relations maintained according to company and legislative requirements.</li> </ul>
9. Personal Performance	<ul style="list-style-type: none"> <li>• Embrace the principle of empowerment by optimising available resources, developing own skillset and accepting responsibility for their job outcomes</li> </ul>
10. Good Corporate achievements	<ul style="list-style-type: none"> <li>• Comply to formalized systems and procedures</li> <li>• SABS ISO 9001 compliance.</li> <li>• System integrity maintained through accurate and updated information.</li> </ul>

## Job Profile

2.3 Job Outputs	
Key Performance Area	Performance Outputs

### 3. REQUIREMENTS PROFILE

3.1 Qualifications		
Type	Area	Importance
NQF Level 1 - 3 Grade 10 - 12	Maths and Science	Essential
NQF Level 6 Diploma / Advance certificate	Analytical chemistry, Chemical engineering or BSc Chemistry	Advantageous

3.2 Professional Status	
Accreditations	
Registrations	
Legal Appointments	
Memberships	

3.3 Experience			
Process/Place/Area	Involvement	Period	Importance
Laboratory	Operational	2-3 year(s)	Essential
Total number of years' experience		2-3 years	Essential

3.4 Competencies		
Type	Description	Proficiency Level
Drivers Licenses	Code B; Motor vehicle licence	
Computer Literacy	Basic computer skills	Intermediate
	SAP	Intermediate
	Excel	Intermediate
	Word	Intermediate
	Powerpoint	Intermediate
		Choose an item.
		Choose an item.
Behavioural Competencies	Strategic orientation - Links current action to strategies (Own / External).	
	Business acumen and industry insights - Understands business driving forces.	

## Job Profile

3.4 Competencies		
Type	Description	Proficiency Level
	Conceptual and innovative thinking - Understands the big picture and questions the way things are done	
	Interpersonal Effectiveness - Understands underlying issues.	
	Team Leadership - Champion's the team.	
	Change Leadership - Initiates changes.	
	Relationship Management - Develops internal-across boundary partnerships.	
	Impact and Influence - Uses indirect influence.	
	People Development - Gives feedback to others.	
	Teamwork - Solicits inputs.	
	Passion for the Customer/Consumer - Business value add.	
	Results Focused - Meets challenging goals.	
	Business Partnering - Boundaryless-proactive business partnering (Internal focus).	
	Concern for SHEQ - Drives the importance of standards to others.	
	<b>Monctional / Technical Competencies</b>	<b>Analytical competencies that include</b> <ul style="list-style-type: none"> <li>➤ Problem solving skills</li> <li>➤ Good knowledge and understanding of Chemistry</li> <li>➤ Good knowledge of XRF and other analytical equipment</li> <li>➤ Root cause analysis</li> <li>➤ Systematic Thinker</li> </ul>
<b>Interpersonal competencies that include</b> <ul style="list-style-type: none"> <li>➤ Good communication</li> <li>➤ Personnel awareness</li> <li>➤ Conflict handling</li> <li>➤ Team work</li> <li>➤ Customer service orientataion</li> </ul>		
<b>Individual competencies must include</b> <ul style="list-style-type: none"> <li>➤ Decisiveness</li> <li>➤ Personal intergrity</li> <li>➤ Persuasiveness</li> <li>➤ Flexibility</li> <li>➤ High tolerance for stress</li> <li>➤ Ability to prioritise</li> </ul>		
<b>Mortivational competencies</b> <ul style="list-style-type: none"> <li>➤ Resilience</li> </ul>		

## Job Profile

3.4 Competencies		
Type	Description	Proficiency Level
	➤ Energy and quality focus	

### DCSA Values

- Integrity
- Customer Care
- Empowerment
- Accountability
- Passion and Enthusiasm

## Addendum E: Certificate of edit

Bruce Conradie  
66 Greenfield Rd  
Greenside  
Tel: 083 461-4130  
[Bruce.conradie@wits.ac.za](mailto:Bruce.conradie@wits.ac.za)

Attention: Annah Manganye  
North-West University

2019-11-22

To whom it may concern

Confirmation of thesis editing

This letter is to confirm that, with the help of a subcontractor, I have edited the thesis/dissertation/article titled:

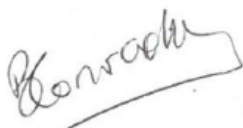
A competency profile and implementation plan for Robolab operators in a South African cement factory

The document was the work of Annah Manganye.

We have edited the document for errors of grammar, punctuation, and style. I have also provided the author with a list of aspects needing further attention or correction.

I am a registered member of the SA Institute of Translators.

Yours faithfully



Bruce Conradie  
Research Support Specialist