Benchmarking an Eskom divisional quality management system

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ABSTRACT

The North West Operating Unit's (NWOU) Network Engineering and Design (NED) department had a number of projects which required rework. The research aimed to determine reasons that led to this rework. The research also investigated the factors that affected quality in the department and proposed solutions on how to overcome these factors.

This was done by firstly verifying that the problem identified was worth studying where a cost and time impact analysis was done on the identified projects. Interviews were also conducted to determine if the problem was specific to one group/region or was it generic. This study showed that; the cost of the rework in the identified projects was more than 14 million Rand whereas the delays ranged from 1 week to 8 months. It was also found that the problem was generic to all regions and groups. Thus it was worth studying.

A supposition was then made that the problem stems from an *inadequate quality management system* and this was confirmed by the root cause analysis study conducted on the 14 identified projects.

A literature survey was then conducted to determine if the available Eskom quality management systems were adequately designed to eliminate rework. From the literature survey information it was evident that the company's quality management systems were in place. However, just like the ISO standards, these were generic and required that a department specific procedure be evaluated. The available department specific process was validated by measuring its ability to address the factors identified in the root cause analysis. In this instance the company's procedures were found to be inadequately designed to prevent rework.

A questionnaire was then designed to measure the level of adherence to the available Eskom quality management system. The results from the questionnaire indicated that there was a relatively high level of adherence to the inadequate, generic quality management system, proving that even though your level of adherence was high; if the QM systems were not adequately designed quality cannot be achieved.

Additional areas of improvement were identified by conducting interviews with senior and junior engineers. This information was analysed using the thematic data analysis and categorised. The category of "M*anagements/Leaderships Commitment to Quality"* was the major contributor to the rework. This was an indication that the QM systems were also not adequately implemented.

The results from the interview were used to suggest changes that can be applied to the NED departmental quality management systems. These suggestions were validated by an ECSA registered senior engineer within the NED department and found to be adequate to minimise the rework even though more detail was needed for the implementation method.

Key Words

- Quality Management
- Quality Assurance
- Eskom
- Network engineering and Design
- Thematic Data analysis
- Requirements
- Documentation Management
- Steak holder liaison
- Decision making
- Rout cause
- Leadership

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ACRONYM DEFINITIONS

Acronym	Meaning
ACNAC	Acquired Customer and Network Asset Creation
CRA	Concept Release Approval
DDT	Distribution Design Technology
DHO	Design Hand Over
DRA	Definition Release Approval
ERA	Execution Release Approval
FRA	Finalisation Release Approval
GOU	Gauteng Operating Unit
HV	High Voltage
IC	Investment Committee
INCOSE	International Council on System Engineering
ISO	International Organisation of Standards
MV	Medium Voltage
NED	Network Engineering and Design
NPV	Net Present Value
NWOU	North West Operating Unit
NWU	North West University
OHS	Occupational Health and Safety
PDRA	Project Definition Readiness assessment
QA	Quality Assurance
QM	Quality Management
QMP	Quality Management Plan
SABS	South African Burro of Standards
SHEQ	Safety Health Environment and Quality
TEF	Technical Evaluation Forum
TQM	Total Quality Management

1. CHAPTER ONE

1.1 Introduction

I started working in the Network Engineering and Design (NED) department within the North West Operating Unit (NWOU) in 2013. The department was responsible for providing engineering support for the electricity distribution systems of the company.

The department was further divided into five groups which were:

- The Control Plant Design group
- The Sub-transmission designs group
- The Distribution Network Design group
- The Civil Designs group and
- The Design Drawings group

I worked for the sub-transmission design group which was responsible mainly for the Primary plant systems and the High Voltage (HV) lines. I joined the group at the same time as all the engineers in the Matlosana zone. The only person who had been there longer was the senior engineer. So we constituted a brand new team with little experience in the new department.

Since the time I had joined the NED department, all the engineers within the Matlosana zone were allocated projects, some were at an advanced stage (past the design stage) and some were relatively new projects, which they had to carry through the remaining activities of the project life cycle. I had noticed that among the projects I was working on, both new and inherited, there was always something to rework.

I then conducted a quick informal survey within the Matlosana sub-transmission group, where I asked if the engineers in this group were having the same problem; i.e. where there was a pervasive need for projects to be reworked. All the engineers in this group indicated that they too had projects that need to be reworked, specifically those that had been in progress when handed over.

To confirm the information from the informal survey I compiled a list of projects which were at construction. I then conducted interviews with engineers and determined what rework needed to be done on each project. Refer to Table 3: From this information I concluded that I was not the only one with the problem, but that there was a problem within the department as a whole. Table 3: also indicates the impact (in terms of time and costs) the rework was estimated to have had on the company. It can be noticed that the rework typically delayed projects by more than a

week per incident and for more than half of the 14 projects, each cost the company over a million rand extra per identified incident.

Note that these were not the only incidents that occurred in these projects. This means that the company may have lost more than the total amount of R 14 487724.82 shown in Table 3.

When looking at the possible issues related to the need to do rework on the projects, my first thought was that the NWOU was a fairly new operating unit and most of the engineers in this sub-transmission were also new, it could be that the department as a whole is on a learning curve.

Based on (Badiru 2013) there is a relationship between the learning curve and quality. The survey suggests that an improvement in quality provides an opportunity for learning which will in turn improve the rate of learning. Therefore I developed a **supposition that a lapse in quality management was at the root of having projects returned to NED for rework**

1.2 Background

This rework affected Eskom's mandate to operate, provide services and ensure reliable electricity to customers (Eskom 2015). According to the (Eskom 2014), ways of ensuring reliable supply of electricity included providing engineering solutions and designs for the refurbishment of the assets, system strengthening and creation of new assets. Within Eskom's distribution business, the Network Engineering and Design (NED) department formed part of the asset creation section in all regions. From the asset creation page in the Eskom intranet (Eskom 2015) it is indicated that, the asset creation within the North West Operating Unit (NWOU) had a vision of:

"Growing the economy and improving the quality of life of the people in the North West Province by:

- *Building substations and major lines to key mining and industrial customers*
- *Electrifying farming communities, households, schools and clinics*
- *Supporting the EPWP of everyday jobs by employing local communities* (Eskom 2015)*"*

This NWOU was a newly formed operating unit which stemmed from the former *Central Region* during the transformation of the distribution business from 6 regions to 9 provinces. The NWOU had to develop its own procedures to suit its own operations using the central region's procedures as reference.

In the takeover process, the NWOU's NED section had to accept the exiting designs, without any interaction/communication between the initial design engineer and the new design engineer, as no formal hand over process was followed in that instance. The new design

engineers were however granted the opportunity to review the designs and change the designs to better improve the quality. Since some of the designs were partially complete and some were complete and ready for construction, the new design engineer had limited scope to modify the design. The modified design packages were then handed over to the Project Management (PM) department for execution.

From the 14 designs that were submitted for execution and construction, all 14 projects were returned to NED for rework, some projects were returned more than once. Refer to Table 3 for the 14 projects that needed rework and their related issues.

1.3 Problem statement

The 14 sub-transmission projects that were sent back to the (NED) department to be reworked resulted in schedule creep and additional/unplanned expenditure. This meant that the customers who were dependent on those projects had to wait even longer, with poor electricity supply, if any, till the projects were complete.

Based on the cost escalations and negative socio-economic impacts enumerated above it was proposed that it may benefit the company to investigate the reason for the reworks with the intention of learning from the mistakes and preventing a recurrence in future. This would ensure that the project execution personnel have the means to ensure that the construction is done correctly the first time.

Besides minimising the need to have designs sent back to NED for re-engineering , this would ensure that reliable asset are created, the personnel safety was addressed and ensured that the project were carried out on time and within the budget and restore the NED department's reputation.

1.4 Aim and Objectives

The aim of this research was to determine the root causes for having projects sent back to NED to be reworked.

This aim was achieved by answering the following questions.

Objective 1: Was poor quality management the cause of the identified projects being returned?

- Analyse the root causes leading to projects being returned to NED and determine trends so as to identify possible corrective actions.
- Verify that the supposition made of quality management being at the root of the need for the rework was accurate.

Objective 2: Were the current Eskom quality management systems adequate to have prevented reworks?

- Conduct a study on the Quality Management (QM) processes currently available in Eskom distribution which are applicable to the NED and measure their applicability to industry standards.
- Use the information gathered from the root cause study and literature survey to validate the existing NED Processes Document (QM processes) and measure its ability to minimise the rework by NED.

Objective 3: To what extent were the Eskom quality management systems adhered to?

- Investigate the level of adherence to Eskom's systems.
- Identify factors/principles of QM not adhered to.

Objective 4: What can be done to improve the Eskom quality management system in NED?

- Make recommendation based on the findings.

1.5 Research strategy

The research was executed in seven different phases:

- The problem identification and verification.
- Determine the root cause for each of the projects which needed rework by NED.
- Review of literature and the company's Quality Management (QM) procedures.
- Validate NED Process Document (Chego 2013) to assess whether had the process been applied, the rework could have been prevented.
- Develop a questionnaire to measure the level of adherence to the Eskom QM systems.
- Conduct interviews with senior and junior staff to identify additional factors that resulted in the reworks.
- Make recommendations for improvement and implementation of the validated NED quality system.

Both qualitative and quantitative research methods were used to analyse the data in this project. Qualitative analysis was done for the root cause analysis and the interviews while the quantitative analysis was done for the questionnaire.

1.6 Dissertation layout

Chapter 1

Chapter one introduces the problem observed, provides a brief introduction that gives the background to the problem. In this chapter a motivation on the necessity of this study is also provided.

Chapter 2

This chapter reviews the available literature related to quality and quality management. It also reviews and compares the available company quality management procedures to the industry quality standards.

Chapter 3

This chapter describes the method used for the determining the reason for the NED rework. It also describes the method used to determine additional factors that played a role in the need for the rework.

Chapter 4

The results from the qualitative and the quantitative research is analysed and discussed in this chapter.

Chapter 5

In this chapter, conclusions based on the outcomes of the research are made and recommendations are made on how to use and improve the existing NED processes document (Chego 2013).

1.7 Summary

This chapter illustrates that the need for rework by NED department had a negative impact on the project duration and costs. It was also noted that some of the work received by the new NWOU NED from the former central region had to be reviewed for applicability and accuracy.

This chapter further indicates that the primary goal of this study was to minimise design rework. The study intended to achieve this by reviewing the existing QM procedure and measuring its ability to reduce the rework. Finally it intended to propose a method of applying the improved QM procedure to the business processes of the NWOU NED.

The next chapter addresses the first objective, of conducting a survey on the processes in place and relating them to the industry standards. This is done in the form of a literature survey.

2. CHAPTER TWO – Literature survey

The literature survey provides information on the history of quality assurance and quality management. It provides the reader with insight in the researcher's understanding of the terms; *quality assurance, quality management, verification and validation*. In this literature survey the applicable industry and company standards and procedures related to quality are also reviews and discusses. More attention is given to the design factors and the factors that affect design, as this study focused on the NED department which mainly dealt with designs of electricity distribution assets.

The qualitative and quantitative research methods are also reviewed in this chapter with the aim of determining the applicable research method for this study.

2.1 Quality and Quality assurance

Dictionaries provided many different definitions of quality. One of the Dictionery.com's (computing 1995) definition on quality was that;

"*Quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs*"

This definition highlights that features (how the customer views the product) are a factor in determining quality. The other point noted from the definition was that quality products were those that address the needs of the customer. Quality based on this definition was determined by the satisfaction of the customer.

However (Juran 1992), in his definition introduced a new element of quality which is the freedom from defects. This element was of interest to both the customer and the producer/service provider. To the customer it meant that the customer would have a reliable product which met his expectations, where as to the producer/service provider, it ensures cost and time efficiency during business operation.

Another definition of quality was given by (N.I. Fisher 2009) as:

"Quality' refers to the way an enterprise goes about its business, inspired by a theory that acts as a guiding principle for behaviour and informed by the knowledge and knowhow needed to make it occur."

At times it was found that the customer did not have an exact idea of what he/she wanted (non-specific requirements) which would make measuring quality quite a challenge. In (N.I. Fisher

2009), it's indicated that, business processes and procedure are one of the elements of ensuring quality and the accuracy of these processes and procedures, developed based on theory, can be used to measure or define quality. Fisher and Nair's (N.I. Fisher 2009) statement reflects on the need for conformance to theory, either in the form of standards or specification. This may be linked to the need to meet specific requirements from customers and other regulating bodies/factors.

quality assurance, being one of the quality management techniques that ensured quality as defined above, is defined by (Keyser, Eugen 2012) in his document, "Engineering Quality Manual," (Document 240-53665024) written for Eskom's engineering departments, as that part of quality management that focuses on providing confidence that the quality requirements can be fulfilled. This same definition was shared also in the ISO 9001 (South African National Standards 2008) standard for quality.

This view was also shared by (Herman Steyn 2008), who indicates that quality assurance relates to giving confidence that the necessary actions for success have been thought, planned and will be progressively audited. This gave confidence to the customer that the quality objectives would be met.

From the information above, one can notice that quality can be measured by comparing the final product to the customer's requirements and other stakeholders' requirements including internal or external regulatory standards. This raised the need of clearly defining the requirements and clearly understanding the requirements in order to measure and ensure quality. From the discussed definitions it was deduce that quality assurance is not an activity alone in isolation. It forms only part of the Quality Management Plan (QMP), thus indicating that quality could not be achieved by only practicing the quality assurance principles. It needed to be managed.

2.2 History of Quality Management

According to the definition provided by (Praxiom_Research_group_limited 2015),

"Quality management includes all the activities that organizations use to direct, control, and coordinate quality. These activities include formulating a quality policy and setting quality objectives. They also include quality planning, quality control, quality assurance, and quality improvement."

According to (N.I. Fisher 2009) the first form of quality management was the "Inspection technique", which dates back to the early 19th century, where the quality inspection was viewed as a specialised task awarded to the qualified craftsmen. These craftsmen were responsible for

both manufacturing and inspecting the product and ensuring that it was produced according to specification.

The inspection technique then developed to a quality control technique where quality inspection departments responsible for monitoring the quality of the products were formed. Later in the 1900's statistical quality control systems such as sampling techniques were applied for quality inspections, where there was no need to inspect each and every product in order to provide confidence on the quality of the products (N.I. Fisher 2009).

Up to that time, the focus on quality was on the product and ensuring during and after manufacturing the quality of the product. The great change on the focus of quality management techniques came about in the 1950's, where the involvement of management and the entire company in quality management is indicated as the key factor to achieving quality. This new technique was termed the Quality Assurance (QA) which took a preventative approach in quality by developing, prior to production, processes and procedure that will give confidence that the product will be produced according to the specification. Note that the previous quality techniques were also embedded in the QA technique (N.I. Fisher 2009).

The latest quality management processes was the Total Quality Management (TQM) which according to (Brian E. Mansir 1989) "*is a means for improving personal effectiveness and performance and for aligning and focusing all individual efforts throughout an organization"*

(Brian E. Mansir 1989) Personalised quality and highlighted the importance of every individual and how the improvement of the individual, his performance and effectiveness, can improve the performance of the company. From (Brian E. Mansir 1989), (Abd El-Moniem 2015) and many other authors it can be noted that TQM was not just a once of fix it was a continuous effort in improving from all individuals in the company in order to improve quality.

Various authors suggested different principles to be adopted in order to effectively implement TQM and achieve continuous improvement. In their literature survey, (Abd El-Moniem 2015) suggested that; *leadership/Management, customer focus, teamwork, continuous improvement, employee involvement and education/training* were the critical principles in order to achieve TQM

(Brian E. Mansir 1989) suggested that; *organisation vision, commitment to quality, customer focus, Process orientation, continuous improvement, system cantered management, investment in knowledge, team work, conservation of human resources, total involvement and commitment to persevere* were the critical principles for continuous improvement.

(Casas 2011) Suggested that the 5 principles of TQM were; *Managements Commitment, focus on the customer and the employee, Facts, continuous improvement and everybody's participation.*

The principles identified by these authors were in line with the 8 principles identified by ISO 9000:2005 (ISO 2015) as; *customer focus, leadership, involvement of people, process approach, system approach to management, continual improvement, factual approach to decision making and mutually beneficial supplier relationships.*

Looking at the principles identified above by different authors, TQM was an inclusive approach to quality management (includes all individuals in the company/organisation) which focused on improving quality and performance in all levels and departments in the company, by adopting the preventative and continuous improvement approach to ensuring customer satisfaction.

In their study, (L. Njenge 2015) found that literature as specified above was indeed correct by stating that TQM improves the company's performance. The results from their (L. Njenge 2015) study showed that, 70% of the studied engineering companies had adopted the TQM principles and 85% of those companies that adopted TQM were ISO 9001 certified and indicated signs of better performance and success.

2.3 Quality as a measure for Project success

Other ways of measuring project success were also investigated. In their quest to prove the importance of Net Present Value (NPV) as a criteria to measure project success (Paul D. Gardinera 2000) implied that time, budget and quality were a criteria used to measure project success. On this research they end up proving that NPV was also a criterion to use for project success however they did not dispute the use of quality as a measure for project success. (Atkinson 1999) was of the view that it was time we accepted that there were other criteria to measure project success that should be explored since we had the iron triangle criteria (time, cost and quality) and yet there were still project that were failing. However he too did not dispute the iron triangle criteria in which quality was one of the criteria of measuring success.

The study of (D. Baccarini 2004) showed that the most important criteria for determining project success was the ability of the project to meet the customers' requirements, which according to the definitions above, was closely related to quality. Thus one can notice that quality was an important criterion for determining project success.

2.4 Factors affecting quality

As indicated by the theory related to TQM in paragraph 2.2 of this document, a quality assurance plan on its own would not ensure that the end product would meet the specified requirements; you also need the commitment of the people using the QM procedure to follow it and support it. While searching for factors affecting quality it was realised that there were no generic factors that affect quality and that different projects and industries had different factors that affect quality. However, the study by (Heravitorbati 2011) suggested that the factors that affect quality can be classified as stakeholder managerial, technical, environment, material, equipment, cultural and political factors. Even though the study focused on the construction stage of the lifecycle it was also applicable at the asset design stages as well. This view was also supported by (Adenuga 2013) who found from his study that ensuring quality was dependent on the stakeholders and designers interface such that the designer may represent the stakeholder's requirement accurately on his designs.

From (Heravitorbati 2011), stakeholder managerial was identified as the biggest problem affecting quality. Section 6.9 of the Engineering Quality Manual (Keyser 2012), which described the duties of different personnel in terms of quality assurance, also implied that, at the operational level, the discipline manager should address issues that were related to the stakeholder management.

This highlighted the need to conduct a study of the relevant customers and stakeholders to be involved in different projects, even though it was not clear whose duty it was to identify the required stake holders for a specific project. From the Company's document (240-64014170 rev0) "Wires Business Project Life Cycle Governance Guideline" (Rabie 2013) it was indicated that the stakeholders should be identified in the initial stages of the project and should be involved in the project planning.

The Engineering Quality Manual (Keyser 2012) also identified other areas that the discipline manager should focus on and these were similar to those identified by (Heravitorbati 2011), however the Engineering Quality Manual (Keyser 2012) did not describe how this was to be achieved. It was the duty of each discipline manager to identify the application method. This was an indication that the Engineering Quality Manual (Keyser 2012) on its own was not adequate to ensure quality (no rework), a discipline specific QM system was also required. The Engineering Quality Manual (Keyser 2012) should be designed to complement the industry standards and requirements.

2.5 Industry requirements VS Eskom Processes

Both the QA and the TQM approaches were highlighted in the industry standards that guided quality. These standards included the International Organisation of Standards (ISO) standards ISO 9000 series and the International Council on System Engineering (INCOSE) handbook. Within the ISO 9000 series was the ISO 9001, which was also adopted by the South African Burro of Standards (SABS) as SANS 9001 standard which related to the **requirements** of a quality management system while the ISO 9004 focused on **how** to make a quality management system more **efficient and effective** (ISO 2015).

ISO 9001 on its own was a generic tool for quality assurance which required companies to prove, prior to production, their ability to meet the quality requirements. Just as indicated in section 1.2 of ISO9001, these requirements may have been the alpha but were not the omega of requirements to achieving quality; the company could do more but not less in order to be certified according to ISO9001. The requirements specified in ISO 9001 were generic and were not specific to a company thus the companies had the responsibility to add detail, from the management level right through to the operational level, to ensure ISO 9001 compliance.

Eskom had at least four documents which described process which helped achieve quality, in the NED department. These documents included; the Engineering Quality Manual (Keyser 2012), the Distribution Asset Management Strategy (Bekker 2010) and the Wires Business Project Life Cycle Governance Guideline (Rabie 2013) and the draft NED Processes Document (Chego 2013).

The processes and workflows described in the identified Eskom documents were managed by the Acquire Customer and Network Asset Creation (ACNAC) tool which was a computer based system that guided the user on the process to be followed in the project life cycle and the responsible persons for the activity execution.

2.5.1. System life cycle

Just as the Systems Engineering Handbook (Haskins 2003), ISO 9001 also promoted the system/process approach to quality management, where departments were interlinked and needed to work together to achieve quality. This brought out the holistic approach to quality management as prescribed by the TQM principles. Section 0.2 of the ISO 9001 standard (South African National Standards 2008) also highlighted the need for continual improvement in quality systems.

(Benjamine S. Blanchard 2006) defined the system life cycle to consist of two phases; the acquisition phase and the utilisation phase. They further divided these two phases into sub phases. Within the acquisition phase, after the identification of the need, was the concept/preliminary design, the detail design and development and the construction or production phases. The utilization phase involved the use of the product and its disposal. From their (Benjamine S. Blanchard 2006) representation of the project life cycle in page 29 fig 2.3 one can note that the phases follow a chronological order where one phase serves as input to the next.

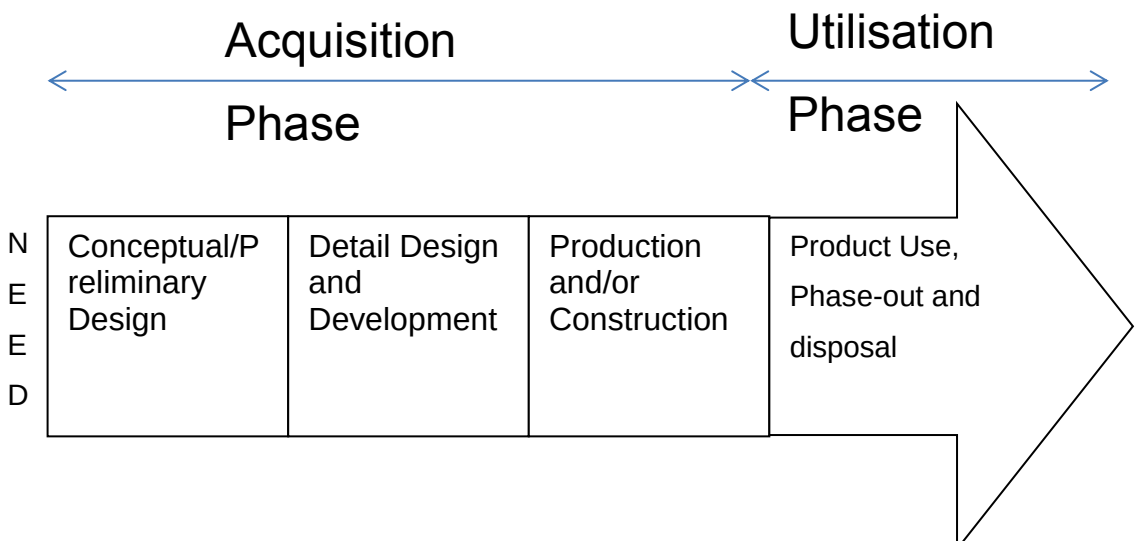


Figure 1: (Benjamine S. Blanchard 2006) representation of a system life cycle.

The INCOSE hand book (Haskins 2003) also acknowledged that the project starts with the need identification followed by the project phases which included; the concept exploration phase, the programme definition and risk reduction phase, the engineering and manufacturing development phase and the utilisation and disposal phase. Refer to the figure below.

N E E D	PHASE O	I	II	III	D I S P O S A L
	CONCEPT EXPLORATION (CE)	PROG. DEFINITION & RISK REDUCTION (PD&RR)	ENGINEERING & MANUFACTURING DEVELOPMENT (EMD)	PRODUCTION, FIELD-ING/DEPLOY, & OPNL. SUPPORT (PFD&OS)	
	1. SYSTEM ANALYSIS 2. REQTS. DEFINITION 3. CONCEPTUAL DESIGN 4. TECHNOLOGY & RISK ASSESSMENT 5. PRELM. COST, SCHED. & PERF. OF RECOMMENDED CONCEPT	6. CONCEPT DESIGN UPDATE 7. SUBSYS. TRADEOFFS 8. PRELIMINARY DESIGN 9. PROTOTYPING, TEST, & EVALUATION 10. INTEGRATION OF MANUFACTURING & SUPPORTABILITY CONSIDERATIONS INTO DESIGN EFFORT	11. DETAIL DESIGN 12. DEVELOPMENT 13. RISK MANAGEMENT 14. DEVELOPMENT TEST & EVALUATION 15. SYSTEM INTEGRATION, TEST, & EVALUATION 16. MANUFACTURING PROCESS VERIFICATION	17. PRODUCTION RATE VERIFICATION 18. OPERATIONAL TEST & EVALUATION 19. DEPLOYMENT 20. OPERATIONAL SUPPORT & UPGRADE 21. RETIREMENT 22. REPLACEMENT PLANNING	

Figure 2: (Haskins 2003) representation of system life cycle

Eskom's representation of the system life cycle involved; the planning phase, the design phase, the acquisition phase, the commissioning phase, the operating and maintaining phase and the retirement phase. (Bekker 2010)

Figure 3: Eskom representation of a system life cycle (Bekker 2010)

Even though the different authors used different phase allocations for the system life cycle, when reading the activities within the phases, it was noticed that the activities that needed to be completed throughout the systems life cycle were the same. However the life cycle represented by INCOSE seemed to give the reader the sense that engineering is part of the construction/production and commissioning phases (Refer to Table 1). Even though the different life cycles did not indicate it, engineering also played a role in the utilisation stages in the form of modifications and utilisation optimisation. Nonetheless this study focused on the phases prior to the utilisation and retirement stages.

Table 1: Representation of different system life cycle of different authors

Author	Life cycle.					
Blanchard and Fabrycky	Concept Design	Detail Design	Production		Utilisation and disposal	
INCOSE	Concept Exploration	PROG Definition and Risk Reduction	Engineering and Manufacturing Development		Utilisation and Disposal	
Eskom	Plan	Design	Acquire	Commission	Operate	Retire

2.5.2. Quality Management at Initial stages

Similar to this research, section 7.3 of ISO 9001 focused more on the quality requirements at the design stage. Section 7.3.1 of ISO 9001 promoted the need for planning prior to design. According to this section the planning should define the project development stages, the validation and verification processes (qualification processes) and the resource utilisation plan and their interface management.

Based on Eskom's "Wire Business Project Life Cycle Governance Guide" document (Document 241-64014170), Eskom uses a standard project life cycle processes, which is based on the system life cycle as described in section 2.5.1 of this document, to define the project development stages where approval should be obtained from the relevant committee prior to commencing to the next phase. Refer to Figure 4 below.

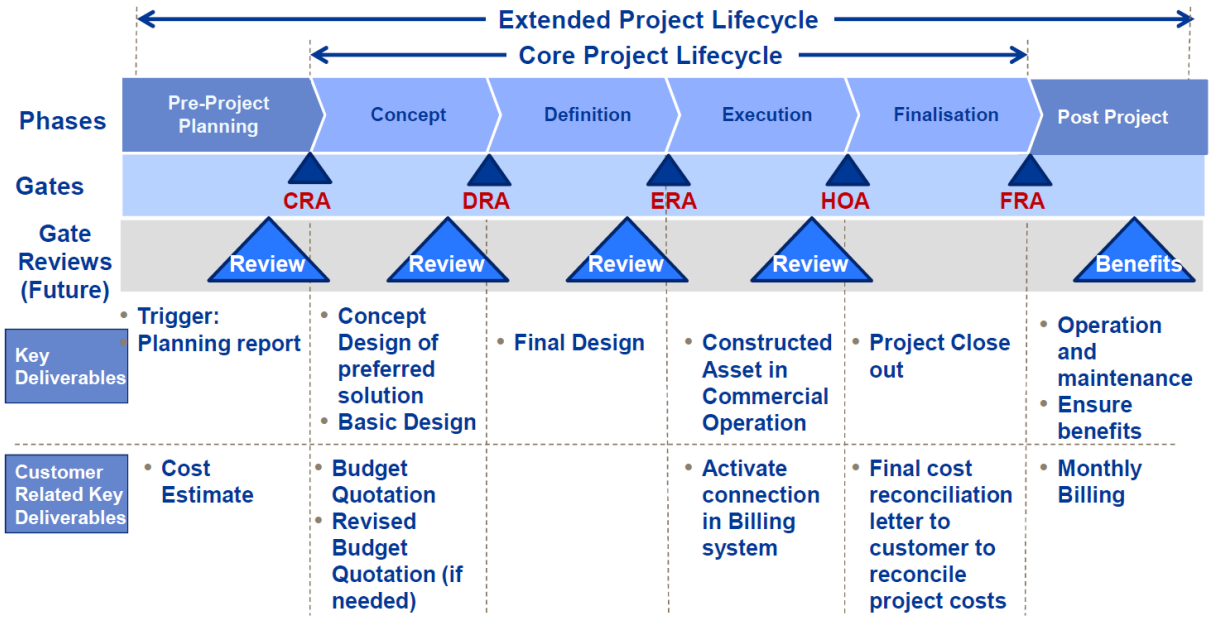


Figure 4: representation of Eskom's Project Life Cycle Model according to (Rabie 2013)

All projects in Eskom ought to have gone through the same stages even though according to this document (Document 240-64014170) the projects were classified according to their complexity, risk, technology and impact on resources. These stages were also used to determine the gate reviews process to be used, which could have been in the form of a Project Definition Readiness Assessment (PDRA), formal gate review meeting and a checklist. These gate reviews verified that all the technical requirements needed to allow the project to the next phase were met. Even though it was not clearly stated in document 240-6401470, the information in paragraph 3.4.3 indicated that the planning department was responsible for doing the feasibility study which on its own was the validation process of the need. Refer to the quotation below.

"Development plans are compiled and contain proposed initiatives that reflect robust network solutions for the identified needs .....A planning report for the preferred alternatives is developed containing benchmarked costing and technical information that will motivate a concept release approval for the project (Rabie 2013).

ISO 9001 also required the organisation to be clear on the responsibilities and authority or personnel especially those who dealt with designs. The ISO document did not indicate the type

of responsibility or authorisation it is talking about however since ISO 9001 was quality related, it was reasoned that the authorisation spoken of was that which was quality management related. In the author of this document's opinion one of the important responsibility and authorisation in the design environment, relative to quality control, was that of approval. Chapter 34 in document 240-6401470 described the gate review process in which it identified different role players in their process and the function in the process.

2.5.3. Author's review of requirements allocation and approvals

Section 7.3.2 of ISO 9001 (South African National Standards 2008) did not address customer requirements allocation and verification activities, these were addressed in section 7.1 to 7.2 which indicated that by the time the project got to the design stage all the customer requirements allocation process should have been complete. However, section 7.3.2 in ISO 9001 identified other sets of requirements (referred to as design inputs in the ISO document) that needed to be adhered to. These included the statutory requirements, functional requirements and any other essential requirements. Eskom developed its own technical standards which were based on the industry standards. The designers needed to adhere to these standards including the industry standards. Such requirements were found in the Distribution Design Technology (DDT) standards and other national standards such as the Occupational Health and Safety (OHS) act, Eskom Safety, Health, Environment and Quality (SHEQ) policy and the South African National Standards (SANS). As much as these standards were available to the Eskom employees question was, were the employees aware of them? Did they know how to apply them? Were they using them?

For substation design the guiding document which guided the designer to the applicable standards was the Generic Substation Design document (document 34-304) which made reference to the technical requirements and the Safety, Health, Environment and Quality (SHEQ) standards.

Section 7.3.2 of ISO 9001 (South African National Standards 2008) also required that the lessons learnt from previous similar designs should serve as input to requirements allocation. This brought about the need to conduct a literature survey prior to designing. The wires business document (document 240-6401470) (Rabie 2013) indicated that the lessons learnt should be recorded at the Finalisation Release Approval (FRA) stage. These should then be fed back to the relevant stakeholders. The ACNAC Workflow Tool had to be used to ensure that these lessons were recorded. Looking at the ACNAC workflow process it was noted that after the FRA stage the information was not fed back to the engineers. The tool did not accommodate the involvement of the engineers at FRA. There needed to be a way of feeding

the FRA information back to the appropriate persons to use as input requirements for the upcoming projects.

Document 240-6401470 (Rabie 2013) indicated that the Planning department was responsible for all users and customer requirements whereas the Asset Creation departments were responsible for all other stakeholder's requirements and their approval.

Section 7.3.3 of ISO 9001 suggested that the required outputs or deliverables from the design stage that would have made the design qualification, project execution and product utilisation possible. At the time of this research the NED sub-transmission department had design document templates which were meant to guide the designer of the expected deliverable and how to document them. However the design template in itself was a design document of the Matlosana Substation project (not so much a template or guide as an example of a completed design).

The document was however suitable for technically reviewing a project and for product construction of projects similar to the Matlosana project and may have proved to be challenging when applied on other projects. This template did not have any information on the product acceptance criteria.

The Gauteng Operating Unit (GOU) Used a tick sheets to review designs which indicated all the requirements to be met in order to ensure that the output met the basic requirements for acceptance/approval. This too was limited as it did not cater for the requirements which were specific to the project as section 7.3.3 of ISO 9001 required. It was suggested that in both regions more effort should be put in identifying the requirements and reviewing the designs based on those requirements.

Section 7.3.4 of ISO 9001 required the company to execute the review plan as indicated in section 7.3.1 at this activity the reviewer checked if the design addressed the requirements specified. The Eskom's comprehensive Design Review Procedure (document 240-53113685) described the design review process for all types of designs in the process. It indicated two design reviews that needed to take place in the design lifecycle as the interim design review and the end of phase design review. The interim review was seen as the review done within the departments by the responsible stakeholders basically checking the design conformance to requirements and standards. The End-of-Phase design review was done to approve the baseline design. One can also note that this document (document 240-53113685) was a guide to indicate how to go about reviewing designs. It however did not give the criterion for acceptance or approval of designs nor did it provide procedures at operational levels. From the information garner in this chapter the researcher proposed that it was the responsibility of the senior engineer to identify the criteria for design acceptance and develop relevant QM

procedures based on the Engineering Quality Manual (Keyser 2012). These criteria may not have been the same for all projects. It should however be agreed on by the senior and the engineer at the initial stages of the project. Doing so and measuring the criteria against the identified requirements also provided the confidence on the design quality. How does one measure if the criteria used will surely provide the solution? The research method selected for this study should be able to address the questions raised in the literature above

2.6 Theory on research methods

(Steven J. Taylor 1998) described qualitative methodology as a research that produced descriptive data. They also pointed out their 8 comments relating to the qualitative research methods which are as follows:

1. It has to do with the meaning people attach to things,
2. It uses logic to draw a conclusion from data,
3. It views people and settings as a whole not as groups,
4. Has an interest on the samples responses,
5. Where all perspectives are worthy of study regardless of status,
6. Allows one to study the samples reaction relative to what he/she says,
7. There is always something to learn from the research and
8. The research method has not been standardised, allowing the researcher a bit of flexibility.

Based on the variance in these comments made regarding qualitative methods it was noted that the qualitative research method was a flexible tool that allowed the researcher an opportunity to interact with the sample. One also got the sense that the research was largely dependent on the data provided by the sample but what if there were to be some exaggeration on the data provided would the researcher not end up with non-accurate results?

Chapter 3 of (Steven J. Taylor 1998) described how one could ensure they obtained reliable data from the sample. this included building a relationship and trust between you and the participants, understanding the participants (language), aligning your attitude to build a relationship with the participant, taking notes accurately during and after formal and casual consultation. Basically, what is highlighted in this chapter is that, the researchers approach to the sample will have an impact on the accuracy and completeness of the data received. Thus one should adjust their approach depending on the sample type and the method of research.

Research Methods

According to (Natasha Mack 2005) there were three basic Qualitative research methods:

- The Participant observation
    - Observations, according to (Patton 2003) were much more than just the researcher's presence and looking around. The researcher needed to be able to capture the sample's response and describe it accurately from these observations the researcher could capture the discrepancies between what the subject/participant had mentioned and what the participant did (Nouria Brikci 2002). Observation of the samples reaction could also be done during an interview session.
- Interview
    - From (Natasha Mack 2005) and (Nouria Brikci 2002), it was noted that interviews were your typical question and answer session where the more the research asked open ended question the more detail he would receive. On the other hand this could end up with the researcher having too much data to analyse which may shift the researcher's focus on the topic of study. In this case (Patton 2003) suggested the different levels of conducting the interviews depending on the depth and accuracy required for the study. One could have; a structured interview with standardised questions, an interview guide approach which identified the topic, a conversational interview which was highly interactive and a focus group.
- Focus groups
    - These focus group interviews may have limited data as some participants may not be open and comfortable to talking in front of others. This type of methods provided the researcher to observe the interaction of the group relative to the information provided by the group.

Authors such as (Nouria Brikci 2002) supported this view of the three Methods of conducting qualitative research however what both authors did not highlighted was the review of written data/documentation, as captured by (Patton 2003). Documentation as described by (Patton 2003) was inclusive of all written material including organisational documents. For this study there was a need to review the organisational documents related to quality assurance in the NED department. The review gave an indication of the level of adherence of the organisational department's processes to the industry standards. The fore mentioned three methods were however also used for the purpose of validation and verification in this study.

2.7 NWU's Definitions for Verification and Validation

The North West Universities (NWU) Faculty of Engineering defined verification as;

*Checking / affirming that a proposed solution to a problem is **correctly implemented**.*

NWU then defines validation as:

*Checking / affirming that the proposed solution to the problem actually solves the problem or is a **valid solution**.*

From the two definitions one can see that verification had to do with the function of the end product, relative to the proposed solution, and the way in which it was produced. This required that the researcher should design his research such that the final report portrayed the researchers design.

In this research the supposition made was verified by conducting a root cause analysis to affirm if the supposition made is accurate.

While validation was more related to the initial requirements and ensuring that these requirements were addressed by the product. This required that the researcher clearly understands and define the problem prior to commencing with the research design.

In this research the requirement were to have a quality management system which ensured that NED's work was done correctly the first time and thus eliminating the need for the rework. In this instance the NED department had the NED processes document which was meant to address this requirement. The researcher validated this document by determining if it addressed any of the identified root causes for the rework.

2.8 Summary and critical review

From the literature survey information, it was evident that quality management undisputedly was one of the criteria of determining project success. This was an indication that investing and focusing on quality would draw the company towards success. The definitions of quality, in the literature survey, indicated that an important measure of quality was to meet the customer's requirements and expectations. To ensure that Eskom met these requirements it developed company standards along with the industry standards which also served as requirements that would ensure quality.

It was reasoned that the key document that guided Eskom's distribution processes was the Wires Business Project Life Cycle Governance Guide (Rabie 2013) document, which, according

to paragraph 2.2 in (Rabie 2013), outlined the process to be followed in handling all Distribution and Transmission Projects in all operating units. However, after reviewing the content of the document (Rabie 2013) in relation to quality management, the researcher concluded that the document focused on describing the processes and responsibilities of the middle management level and had very little information regarding the quality management processes and procedures at the operation level. After reviewing other documents related to quality it was found that the reviewed Eskom documents were compatible with the industry standards specifically ISO 9001. Paragraph 1.2 in the ISO 9001 standards states that:

"*All requirements of this international standard are generic and are intended to be applicable to all organizations, regardless of type, size and product provided*".

Looking at this statement it was concluded that just as the reviewed Eskom documents the ISO 9001 standard was generic and broad which would not cater for the division specific requirements. The company could do more to complement ISO 9001 by looking at a division specific quality management system. The Wires Business Project Life Cycle Governance Guide (Rabie 2013) and the Engineering Quality Manual (Keyser 2012) document could be used as a baseline in improving the quality management processes at a divisional level.

The review of the available divisional quality management procedure for the NED department is discussed in paragraph 4.3.2 of this document while the following chapter 3 uses the information from the literature survey as input for designing the research strategy which will determine the root causes for the rework, and ways to prevent a recurrence of the problem

3. CHAPTER THREE - Investigation design

This chapter indicates the steps taken to investigate the reason for projects being returned to NED after the design stage. It also outlines process followed to obtaining a possible solution for these returned projects.

3.1. Problem identification

The investigation was triggered by the concerns of an engineer who had projects returned for rework when they were at an advanced stage. In order to verify that a systemic problem actually existed and that it was worth investigating, interviews were conducted with the NED personnel in Matlosana and the senior engineers from various regions and groups in the NWOU's NED department. From the response to the interviews a list of projects that had been returned at the Matlosana zone was compiled with the issues that needed rework. A financial analysis of the identified project was conducted to measure the cost impact on the company, to **validate** the need for the research to be conducted. With this information on hand a supposition, to be verified by this research, was made as to what was the root cause for the rework.

3.2. Root Cause analysis

In order to be able to support a supposition for the reason why there was a need for rework, a root cause analysis was done on the identified projects. A root cause analysis form was developed, which had to be completed by the engineers working on the projects identified in Table 3. The engineers selected to head the root cause analysis on the projects identified in Table 3, were better suited to do so as they are the custodian engineers for those project and would have more information than the researcher on the project activities. This will also support the quest for continuous improvement for the engineers (allow them to learn from their and other's mistakes).

This root cause analysis information was then evaluated and analysed by using the "thematic data analysis method" to identify the factors causing the 14 identified projects to be returned for revision. Since a thematic data analysis was done for these root causes the forms were acceptable if the following fields had been completed:

- The background,
- The observation,
- The contributing causes and the
- Root cause.

3.3. Review of Literature and company's Quality Management (QM) procedures

In the literature survey an investigation was conducted to determine the compatibility of the systems and processes, relating to the project life cycle and ensuring project success, put in place by the company and those available in similar industries. In this investigation the company's documentation including the external literature which they refer to was reviewed and assessed to form a conclusion on the company's standing relative to the industry standards.

3.4. Validate the NED Processes Document

In the root cause analysis factors that led to the NED rework were identified. These factors were used to affirm if the NED document actually addresses these identified factors and is it a valid solution that will solve the problem. This will confirm if the available Eskom QM systems are adequately designed or not.

3.5. Questionnaire measuring Level of adherence to Eskom QM systems

This questionnaire aimed to determine to what extent the Eskom quality management systems were adhered to by the engineers and seniors when executing design projects. The questionnaire was therefore distributed to all NED engineers within the NWOU to complete.

The questionnaire was designed, based on the information gathered in the literature survey relating to the company's and industry requirements to be fulfilled in order to obtain quality designs. A Likert scale was used to quantify the response to each question where data obtained was analysed using a thematic data analysis.

In the data analysis the questions were categorised and the categories indicated in Table 2 were tested in the questionnaire to measure the level of adherence to the company's processes for quality assurance.

Table 2: questions representing categories

Category	Represented by question
Input information and requirements	1,2,5,8,9,10,16,17
Documentation Management	12,18,19,20,21,32,33,34,35,39
Stakeholders Management	3,4,6,7,11,13,14,15,41,48
Deliverables and templates	22,23,24,25,26,29,30,31,
Continuous improvement	36,37,40,46,47
Project reviews	27,28,42,43,44,45

The response in the questionnaire was regarded as invalid if:

- More than one answer was marked for the same question.
- The question was not answered.
- There was no clear indication as to which answer is selected.

Not the entire questionnaire was disregarded but only the invalid question was disregarded when analysing the data.

The questionnaire also had a comments section where the comments would be used to gather further information regarding the problem designs. Refer to Appendix A2: Questionnaire Forms to view the questionnaire.

The questionnaire also addressed additional factors that affected QM that had not been identified by the root cause analysis, but needed to be included from a holistic point of view.

3.6. Interviews to determine additional factors affecting quality

This section aimed to determine other factors that affect quality within the NED department.

A group of respondents (senior personnel that worked with major projects) were identified from different groups, within the NED department. The senior personnel were selected as respondents since one of their primary functions was to manage technical work within the different groups. These seniors were expected to have information on all projects and were able to provide the general challenges they faced and know if there were any projects returned to their departments for rework.

From the interview two questions were asked. The first question was;

“In your groups, do you have projects that have been at an advanced stage being returned to your group for rework?”

This required a Yes or No answer however the respondents were given an opportunity to elaborate. The response to this question was used to verify the identified problem.

The follow up question was an open ended question that asked;

"Relative to the projects that had been returned in the group, what were the factors that led to these projects being returned?"

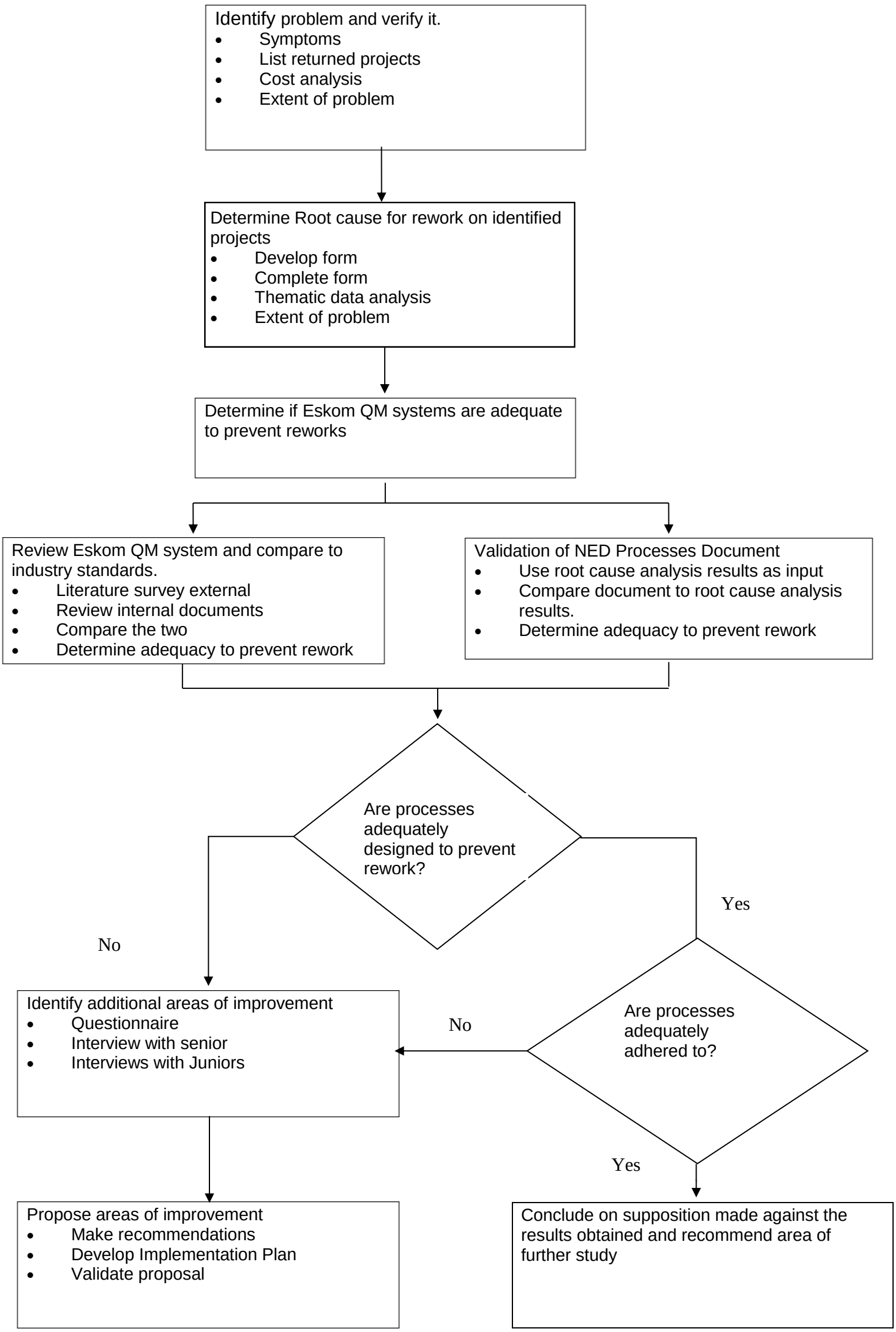
The same questions were also posed to the junior staff from different groups within the NED department to get data which wasn't biased. However in this instance a forum was created with representative from each group within the NED and in the form of a brain storming session where the above mentioned questions were answered.

The data from the senior's interview and the junior's forum were analysed separately, using a thematic data analysis method, and compared. The aim of these interviews was to identify the common factors that result in rework and related these factors in an area of study.

Based on the studies Identified above recommendations on how the divisional quality management system could be improved with in the NED were made by the researcher. These recommendations included the methods of implementation and were validated in an interview with the company's senior engineer.

3.7. Summary

The experimental design is summarised in the flow diagram below



The results to the designed study are discussed in Chapter four of this document.

4. CHAPTER FOUR – Results and discussion

The previous chapter outlined the experimental process followed in this dissertation. Chapter four reports on the findings and discusses the results of this study.

In this chapter the following results will be presented and discussed in separate sections:

- Prove supposition that “a lapse in quality management was at the root of having projects returned to NED for rework” to be true or false,
- Study on existing quality management systems,
- Factors affecting project rework at NED and
- Validation of the existing NED Processes Document.

All of the above results are consolidated in the summary of this chapter and conclusions based on the discussion are provided in chapter 5.

4.1. Results – Problem identification and Verification

Informal interviews were conducted with 10 NED engineers who work with Major projects in the Matlosana zone

- Three representative from the Medium Voltage (MV) design group,
- Three representative from the Control Plant design group and
- Four representatives from the Primary Plant (High Voltage and Sub-transmission) design group.

Formal interviews were conducted with 7 senior personnel who represent different regions and groups within the NED Department.

- There was one senior represented from the High Voltage (HV) line designs for the entire NWOU.
- There was one senior represented from the civil designs group for the entire NWOU.
- There was one senior represented from the drawing group for the entire NWOU.
- There were two seniors representing the sub-transmission group. One was representing the Matlosana zone and the other the Platinum zone.
- There was one senior representing the control plant group for the entire NWOU.
- The senior representing the Medium Voltage (MV) design group was not available at any time to assist with the research and in order to get representative information an engineer with the most experience among the rest who did not form part of the juniors’ forum was interviewed.

An analysis was done based on the identified 14 projects that needed rework to determine the impact of the rework on time and cost.

From the informal interviews conducted with the personnel in the NWOU NED department in the Matlosana zone who work on major projects, all the respondents indicated that they had projects that needed rework.

From the seniors interviews all the respondents excluding the senior representing the Civil engineering group indicated that within their regions and groups there were projects that required rework.

The time and cost analysis indicated that the company lost over R14,487,724.00 in the studied problems in the 14 projects. Refer to Table 3.

Note that this was only for the identified problems on each project and in some projects the rework was required more than once. The time delay due to these problems ranged from two weeks to 10 months delay

This was an indication that the problem of having projects returned to NED for rework was not an isolated problem and prevailed in all regions and in all groups within the NWOU's NED department. This rework led to a significant financial loss to the company and delayed projects. It was concluded that the reason leading to the rework by the NWOU's NED was worth investigating.

Table 3: List of project under construction, issues related and their impact on the company

Project	Incident Description	Total cost	Incident impact on time [months]	Incident impact on cost			
				IDC	Overheads	Additional material and Labour	total
Charles Shaft -New 20MVA, 88-11kV Transformer	During construction the isolator was found to be violating the working clearances where when it opens the swing arm was touching the nearby column	R 27 182 000.00	0.5	R 114 843.95	R 113 258.33	R 21 200.00	R 249 302.28
Gopani Mine - Install additional 20MVA 88-22kV trf & 3x22kV feeder bays	There was an additional scope of work required for successful execution of the project.	R 10 252 677.21	6	R 519 810.73	R 512 633.86	R 2 531 739.95	R 3 564 184.55
Klerksdorp North-New 20MVA, 132-11kV Transformer	Earthmat conditions were found to be substandard	R 12 102 945.00	6	R 613 619.31	R 605 147.25	R 1 033 440.00	R 2 252 206.56
Klerksdorp West- New 88/11kV, 10MVA Transformer_4	The designed firewall was not constructible	R 12 966 473.00	No time delay. Problem identified before construction date	R -	R -	R 71 821.86	R 71 821.86
Leeudoringstad 88/11kV	Scope change from indoor system to outdoor systems	R 12 200 000.00	10	R 1 030 900.00	R 1 016 666.67	R -	R 2 047 566.67
Lykso	there was an additional scope of work required to solve the problem	R 3 194 227.58	4	R 107 964.89	R 106 474.25	R -	R 214 439.14
Vuthlari 88/11kV 2X20MVA new substation	There was a request to add a new feeder at 22kV	R 30 400 000.00	2	R 513 760.00	R 506 666.67	R -	R 1 020 426.67
Matlosana New 132/11kV 2x20MVA	Material ordered for construction does not correspond with the issued design	R 40 714 134.00	3.5	R 1 204 120.51	R 1 187 495.58	R 65 020.00	R 2 456 636.09
Straatsdrift rural install additional 10MVA	Available equipment does not fit on the designed structures.	R 19 000 000.00	0.5	R 80 275.00	R 79 166,67	R 8 590.00	R 168 031.67
Zeerust Munic – Replace 88-11kV 5MVA & 10MVA with 88-11kV 2x20MVA transformers	Additional scope of work was required for the project.	Project is still going to the investment committee for approval	No time delay	R -	R -	R -	R -
Henningvlei	Insufficient funding resulted in scope change	R 3 060 000.00	8	R 206 856.00	R 204 000.00	R 787 000.00	R 1 197 856.00
Ferndale	Additional feeders are no longer required and feeders need to be rearranged.	R 9 200 000.00	8	R 621 920.00	R 613 333.33		R 1 235 253.33
Dellareyville	Oil dam pipe work goes under cable trench resulting in impractical slope		No time delay oil dam construction cancelled. Drill draining hole on bund wall.	R -	R -	R 10 000.00	R 10 000.00
Totals		R 180 272 456,79		R 5 014 070,40	R 4 944 842,60	R4 528 811,81	R 14 487 724,82

4.2. Results - Root cause analysis

As indicated in the previous paragraph the intention of the root cause analysis was to determine the reason why the 14 identified projects had to be returned to NED. The intention was to complete a root cause analysis for all 14 projects however only 10 projects were analysed. This exercise was viewed by some engineers as a tedious paper exercise. Therefore in order to ensure that the data received was accurate the researcher had to review the submitted root cause analysis.

The root cause analysis indicated that there were different root causes for each project in the analysed 10 projects.

A thematic data analysis was also done based on the data provided on the root cause analysis forms. While doing the thematic data analysis, the information gathered in these root cause analysis forms was arranged into the following 5 non-preconceived categories:

- Documentation and information,
- Processes and Procedures,
- Project Management,
- Customer and suppliers relations and
- Management and Leadership commitment to quality

The category of documentation and information was raised in all the projects that were analysed. This was an indication that on all the analysed projects the documentation and information management category was not well managed. The dominating categories per project are tabled with the root cause in Table 4.

Table 4: summary of the findings from the root cause analysis per project and its dominating category

Project	Root cause	Relation to quality	Dominating category
Charles Shaft	Hand over process to new engineer was not done.	Insufficient information to ensure factual approach to decision making: Principle 7	Documentation and information
Gopane mine	Project requirements not analysed and managed	Insufficient information to ensure factual approach to decision making: Principle 7	Stakeholders management

Project	Root cause	Relation to quality	Dominating category
Klerksdorp North	Earth mat was not tested as TEF requested.	Insufficient information to ensure factual approach to decision making: Principle 7	Documentation and Information
Klerksdorp West	Stakeholders Analysis was not conducted	No mutual beneficial supplier relationship: Principle 8	Documentation and information
Leeudoringstad	Design is constructed later when the design was outdated.	Customers' requirements/specification was not addressed: principle 1	Processes and procedures
Lykso	No proper hand over process was followed	Insufficient information to ensure factual approach to decision making: Principle 7	Documentation and information
Matlosana	Stakeholders were not informed of change and project progress	Lack of customer and supplier involvement and information sharing: Principle 8	Project Management
Straatsdrift	Material Purchased did not meet the design specification	Customers' requirements/specification was not addressed: principle 1	Documentation and information
Vutlhare	Training facilities available are old and outdated	Continuous improvement was not practiced: Principle 6	Project Management
Zeerust	Available existing drawings are not up to date.	Insufficient information to ensure factual approach to decision making: Principle 7	Documentation and Information

The information in Table 4 indicates that the root cause for each project related to at least one quality management principle that was not adhered to and the root causes from the different projects were mostly related to the Documentation and Information category.

Table 5: analysis of category information

Category	Identified factors	Discussion	Deliberation
Documentation and Information	*insufficient/inaccurate input information and requirements, no hand over process followed, documentation and information not effectively controlled*	One of the principles of quality as identified by (ISO 2015) is that effective decisions are based on the analysis of data and information and in order to conduct accurate analysis the input information needs to be sufficient, accurate and reliable, accessible and be able to reference factual previous records	Quality management principles not adhered to
Processes and Procedures	t*echnical approval process not followed, design process not followed, project life cycle procedure not followed*	(ISO 2015) indicates that *"A desired result is achieved more efficiently when activities and related resources are managed as a process."* Eskom has procedures that describe the processes that describe the project life cycle and the data in this category indicates that the procedures as identified by Eskom were not followed.	Quality management principles not adhered to
Project management	*Inaccurate material acquisition, quality controls not done and delayed implementation*.	The literature survey information in chapter two shows that quality is measured by the ability to meet the identified customer requirements during construction NED becomes the customer to the Project Management (execution) department and the requirements are specified by the design. If the material purchased is not according to the	Principle 1 of (ISO 2015) not adhered to

Category	Identified factors	Discussion	Deliberation
		designers requirements/specification quality is compromised.	
Customer and suppliers relations	*There was a lack of participation and inclusion of customers and suppliers through the project life cycle.*	Principle 8 of the ISO 9000 encourages mutually beneficial relationship between supplier and the organisation, which is achieved by Identifying and selecting the key suppliers and establishing relationships, having clear communication, sharing information and establishment of improvement activities.	Principle 8 of (ISO 2015) not adhered to
Management/Leadership commitment to quality	*the decision made by the departments leadership allow for bypassing the QM process, restricting participation of engineers in the QM process and, encouraged the use of old technology (limit improvement)*	Principles 2 of the 8 ISO 9000 principles indicate that Leadership should create and maintain the internal environment where people become fully involved in achieving organisation's objectives.	Principle 2 of (ISO 2015) was not adhered to.

The information gathered in each category is analysed in Table 5. This information in Table 5 indicates that in each category the factors identified were related to the lack of quality management.

Based on the analysis in both Table 4 and Table 5 it was concluded that the causes for rework by NED was related to a lack of adequate Quality Management.

4.3. Results – Review of literature and the company's (QM) procedures

Based on the information and conclusion made in paragraph 2.5 of this Dissertation a well-structured and implemented QM process is capable of ensuring that the NED work is completed correctly the first time (no reworks). In this paragraph the results from reviewing the available company QM processes are discussed

4.3.1. Generic quality management processes

Paragraph 2.5 of this document reviews the available company QM processes, where it was found that the generic Eskom QM processes and procedures were compatible with those indicated by the industry guidelines. Based on the literature survey information it is concluded that since these processes were not specific to a department they were not adequate to prevent rework. Section 6.9.4 in (Keyser, Eugen 2012) indicated that the discipline managers are responsible for determining processes and documents for their specific division. The NED Processes Document was therefore developed to address the divisional quality management requirements.

4.3.2. Validating the "NED Processes Document"

The NED Processes Document was drafted in 2013 to primarily address Safety Health, Environmental and Quality (SHEQ) requirements. This document had since not been approved or made an official business document remaining a draft. This document outlined the focus areas for the department which also indicated the actions to be taken in order to meet these focus areas. It also described the work flow process for the different groups in NED and also provided links to the applicable NED documents and templates

The focus areas identified in the NED Processes Document included;

- Safety
- Alignment to the rolling plan

- Stakeholders Liaison,
- **Accuracy, quality and turnaround time**
- Skills development
- Electrification support and
- Data accuracy

Some of the focus areas identified in the NED Processes Document (Chego 2013) were similar to the categories identified in this study, they have just been worded differently refer to Table 6 below.

Table 6: Relationship between NED Processes Document's focus area and the root cause analysis categories

Root cause analysis categories	NED Processes document Focus areas
Documentation and information	Data accuracy
Processes and Procedures	Accuracy quality and turnaround time
Project Management	Not a focus area
Customer and supplier relations	Stakeholder Liaison
Management /Leadership commitment to quality	Alignment to rolling plan is a management function (partially addressing leadership commitment to quality

The NED Processes Document included the electrification processes while this research focussed on major projects.

Documentation and information

The NED Processes Document recognised the need for accurate data control and management in the data accuracy focus area. In this focus area the actions identified are; to update the substations as-built drawings, update of small world (company's network application that records the network data) and documentation control and assigns the responsible persons to address these activities. Section 3.5.4 in (Chego 2013) specifies that the Hyperwave documentation control system should be fully utilised. The documentation control was identified as one of the factors that led to NED rework in the root cause analysis

The document however does not provide the strategy to be adopted in order to address these activities and the actions have remained open since the inception of the document. The document also does not address the other factors identified in the root cause analysis study.

Thus this category of *Documentation and Information* was not fully addressed by this document.

Processes and Procedures

The NED Processes Document indicated the work processes and their deliverables for each group in NED and under the Stakeholder's Liaison focus area. It also indicates the need for process alignment. It however does not specify what will be done to ensure that the processes are aligned with what is happening in the department. Section 3.6 in the document also indicates that if a project has not followed the processes identified by the companies QM procedures, such as. (Rabie 2013), and advances to the next stage, it should be returned to the previous stage.

In this instance the document satisfactory addressed the factor of *Project Life Cycle procedure not followed* identified in the root cause analysis study but did not address the *Technical approval process not followed* and *Design Process not followed* factors.

Thus this category was not fully addressed by the NED Processes Document.

Project Management

The project Management as a department has been identified as the primary customer (stakeholder) in section 3.7 of the NED Processes Document. The activities conducted in the Project Management department may be dependent on the input from NED and from this study there was no indication of any problems regarding the information from NED to Project Management.

The information from this study may be shared with the project management department to review their own processes of quality assurance.

Customer and suppliers relations

The factors identified in this category were; *there was a lack of participation and inclusion of different customers and suppliers through the project life cycle.*

Section 3.7 of the NED Processes Document indicates that the means of ensuring customer satisfaction is by introducing the quality e-rating form on the NED score card where, in each project, the customer will rate the services provided by NED. Even the NED workflow processes. This would ensure the participation and inclusion of the customer in the project life cycle activities.

In this category the identified factors for rework were addressed by the document.

Management/Leadership commitment to quality

The factor identified in this category were that *the decision made by the department's leadership allow for bypassing the process and restricting participation of engineers in the Quality management process and, encouraged the use of old technology (limit improvement)*

The NED Processes Document indicates the focus area of Alignment to the rolling plan. This focus area partially addresses the concern raised in terms of information gap between the managers and the employees. The activities that need to be addressed in this focus area include the prioritisation of projects on the rolling plan, the resource allocation and the plan for the 2014/2015 financial year. This report or strategy was however not indicated or referenced in this document and thus did not completely address the concerns raised in this study.

Section 3.6 of the document addresses the factor raised by the root cause analysis study of *managers making decision to bypass the QM process.* Section 3.6 states that if a project advances to the next stage without going through the quality management process of the previous stage it should be returned to the previous stage.

The document however does not address the other factors identified by the root cause analysis study in this category

In this category the factors identified by the root cause analysis were partially addressed

4.3.3. Discussion

Based on the above information it can be concluded that the generic company QM processes were in line with the industry standards.

The NED specific QM processes NED Processes Document (Chego 2013) partially addressed the factors identified in the root cause analysis study. Thus, even if the document (Chego 2013) was applied and adhered to it was not able to prevent the need for rework by NED.

4.4. Results - Level of Adherence to Company's and industry QM Processes

The literature survey results in paragraph 4.3 indicated that, even though the company had quality management processes that were compatible to the industry standards these were generic and were therefore not adequate to prevent rework. To measure the level of adherence to these generic QM processes a questionnaire was developed.

4.4.1. Questionnaire

This questionnaire was distributed to all engineers working on Major projects in the NED department however not all the issued questionnaires were returned. Due to the slow response in terms of the questionnaires returned each individual who had not responded was called and reminded to return the completed questionnaires. Telephonic interviews were conducted with those who had not responded by the closing date where the questions on the questionnaire were read out to the respondent and their response was recorded for them on the questionnaire form. In the end from the 36 issued questionnaires 30 had been completed. Refer to Table 7.

Table 7: Summary of Questionnaires Issued and Returned

Section	Issued	Not returned	Returned	interview
Primary Plan group (sub-transmission and HV lines)	12	1	11	0
Control plant group	12	1	11	0
Medium Voltage group	10	4	3	3
Civil group	2	0	2	0
Total	36	6	27	3

The respondents however queried the question of designation where they indicated that there designation was not indicated as an option. It was explained to the respondents that according to HR the respondents who were recorded as technicians were employed to conduct an engineer's function. The only reasons they were termed technicians was because they did not have the qualification according to the company's HR requirements to be termed engineers. Thus all engineers and technicians and technologists were grouped together as engineers and the personnel who played a supervisory role were grouped together as seniors in this research.

In each question the Likert mean, based on the response to each question, was calculated and represented in percentage form. Where the responses, with respects to how many respondents

selected a specific answer in the questionnaire, were also represented in percentage form. These Likert mean percentages were graded as follows:

- Anything less than 60% indicated low level of adherence
- Anything between 60%-75% indicated a moderate level of adherence
- Anything above 75% indicated a high level of adherence

This was applicable to all questions except for questions 1, 23, 25 and 30 (termed negative questions in this document). The response in these questions was graded as follows:

- Anything above 40% indicated a low level of adherence
- Anything between 25% and 40% indicated a moderate level of adherence and
- Anything less than 25% indicated a high level of adherence

Refer to *Appendix A3: Questionnaire analysis raw data* for the raw data used to develop the graphs in the analysis of each category.

Input information and Requirements category results.

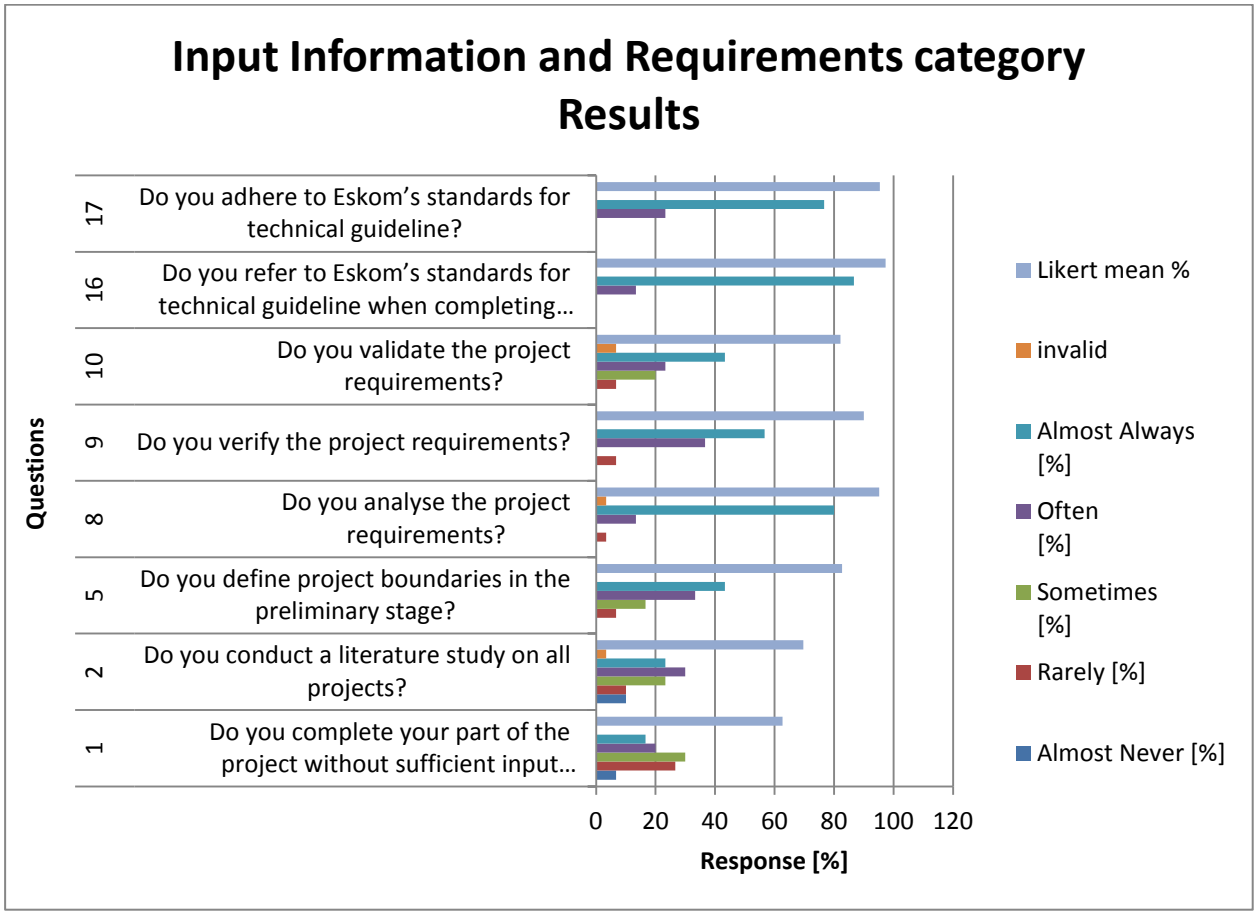


Figure 5: graphical representation of Input Information and requirements category results

In this category the Likert mean percentage for all questions excluding question 1 and 2 were all above 82% indicating that in general there was a high level of adherence to the Eskom process. This was an indication that prior to designing an analysis was done on the projects input information. However according to the response of question 1 it appears that engineers still continued with the project even though they did not have enough information. The result of question 1 indicated a low level of adherence, whereas the results of question 2 indicated a moderate level of adherence (69%) where the literature study was only done sometimes.

Documentation Management category results

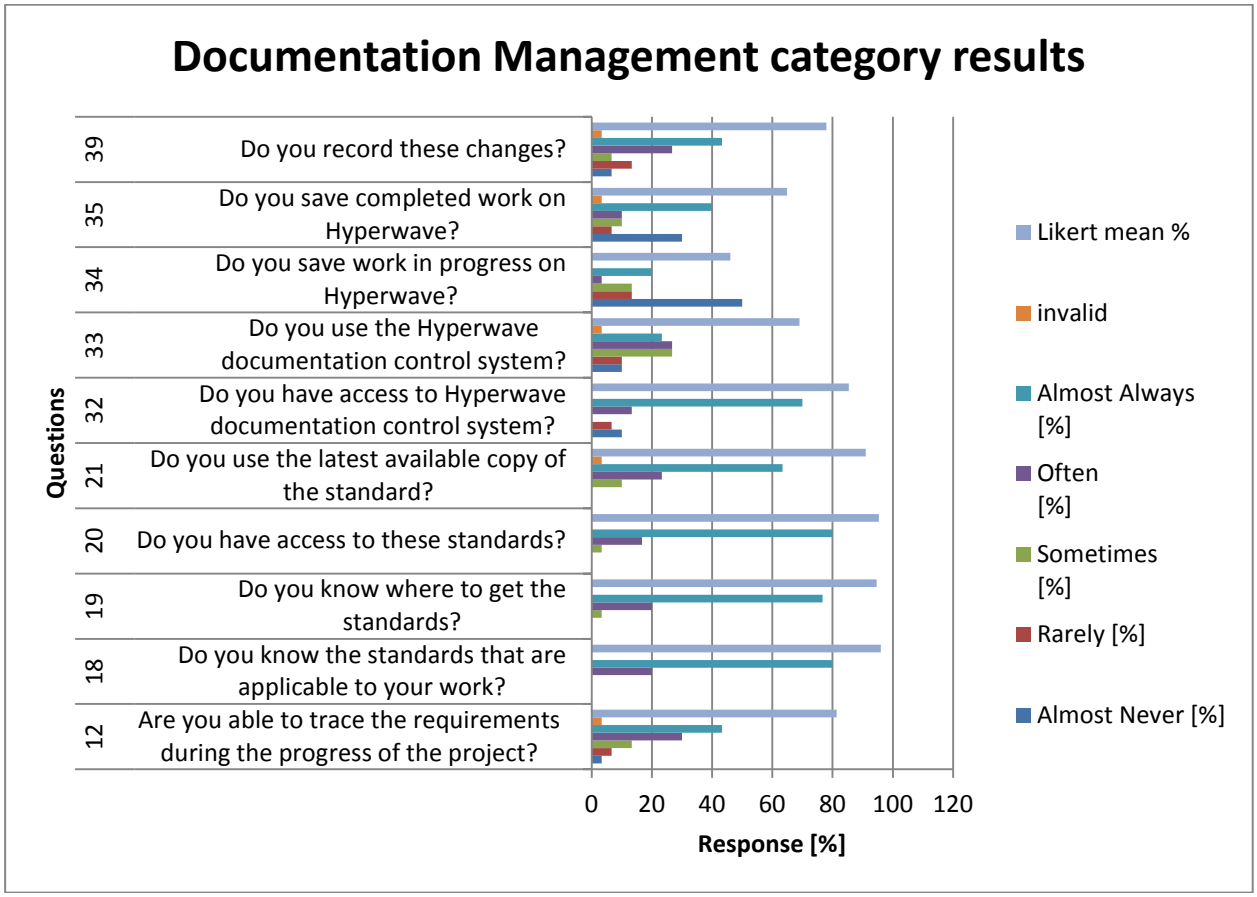


Figure 6: graphical representation of Input Information and requirements category results

In general, the documentation management category results indicated that there was a high level of adherence to Eskom's process and the requirements for quality assurance. This was indicated by the mean percentages that were above 79% on all questions except for question 33, 34 and 35. These were the areas of concern that related to the use of the documentation control system, Hyperwave. From the data results it was noticed that only 46% of the time data was stored on Hyperwave. If there was insufficient or inaccurate information stored on Hyperwave the continuous improvement aspects of quality and the literature study aspects would be affect. This may have also resulted in insufficient input information when projects needed to be handed over or an engineer handling the project was no longer available.

Stakeholder Management Category results

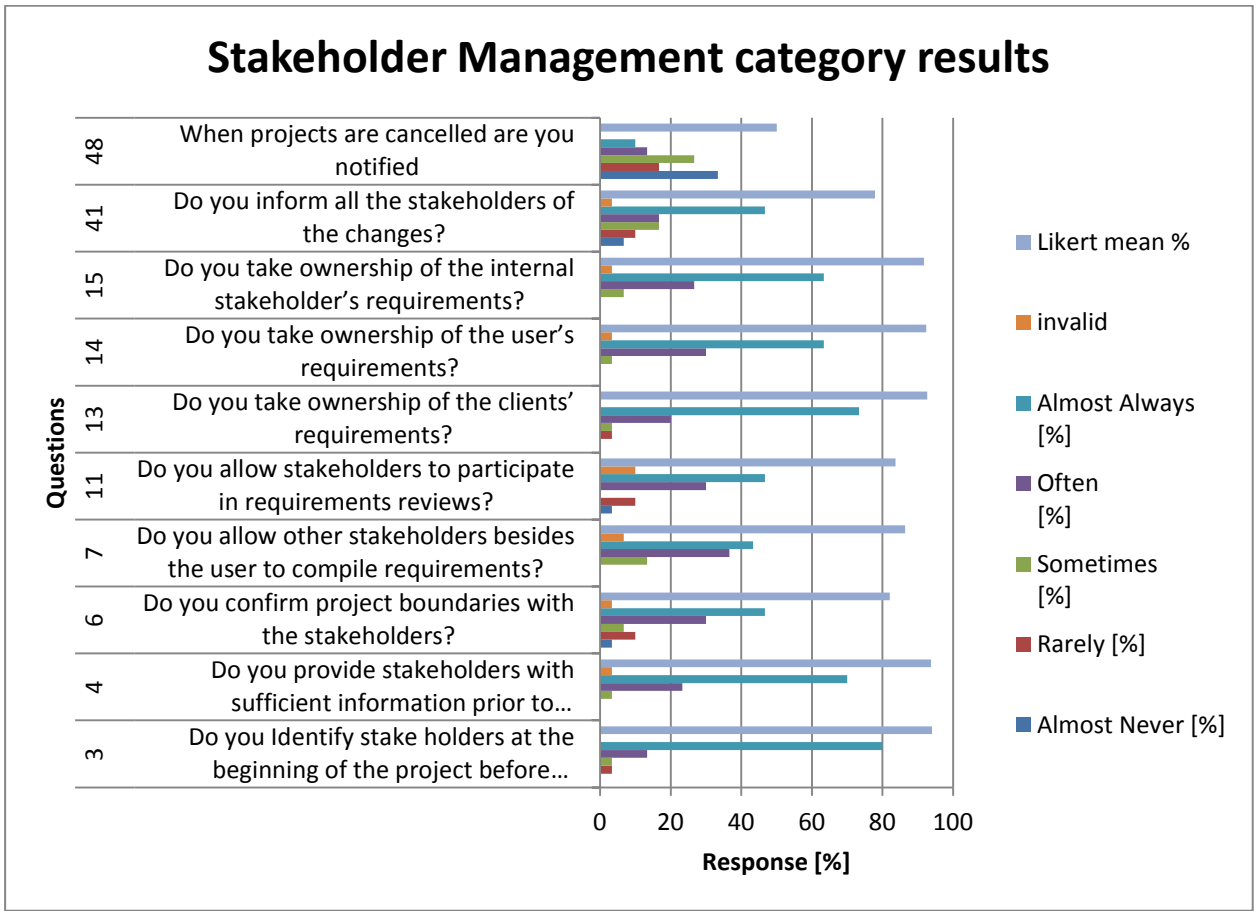


Figure 7: Graphical representation of Stakeholder Management category results

In this category, the Likert mean percentages for all questions, excluding question 48, were all above 77% indicating that in general there was a high level of adherence to the Eskom process. However, according to the response of question 48, where the mean percentage was 50%, it can be noticed that even though the NED department managed its stakeholders well, they were not included by the other stakeholders when it comes to projects being cancelled. This exclusion in project cancellation was an opportunity lost by the engineers to conduct a post mortems and thus affected the continuous improvement aspects of quality.

Deliverables and Templates category results

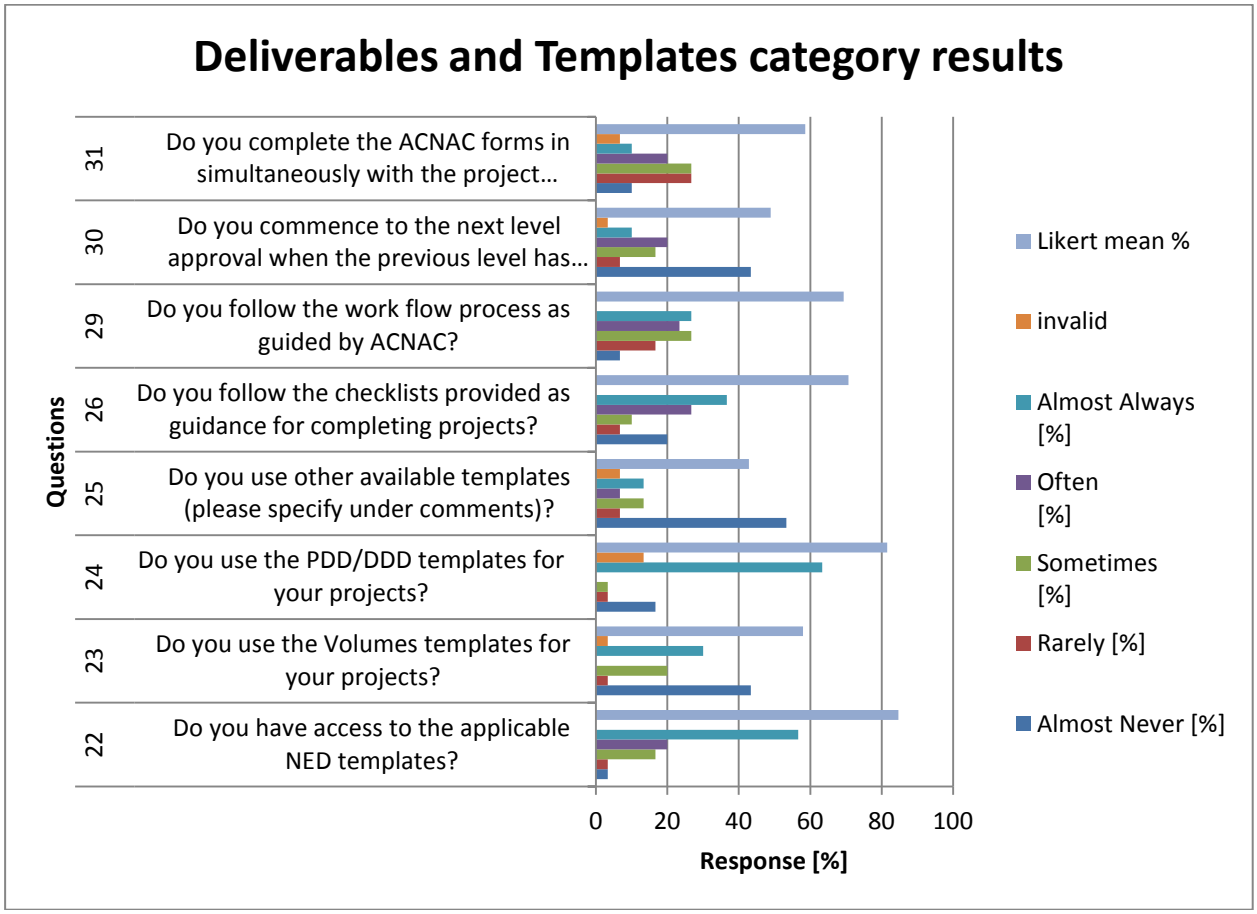


Figure 8: Graphical representation of Deliverables and Templates category results

In this category in general the level of adherence to Eskom's process of quality assurance was low. From this category it was noticed that the available systems (ACNAC), Checklists and templates put in place to monitor and assure quality were not adhered to. With regards to templates, even though the Likert mean percentage for the use of PDD/DDD templates and the access to all templates are above 81%, there seemed to be no clarity among the engineers as to which templates should be used. This uncertainty resulted in engineers using other templates which may not be NED approved (refer to question 25 where the mean is above 40% indicating a low level of adherence. Since it is a negative question anything above 40% indicates low level of adherence).

According to (Tech target n.d.), a template is a form or mould that is used as a guide to making something. Therefore it can be said that templates are available to ensure uniformity they are also used as a guiding tools that ensure that certain criteria are met before a deliverable can be produced. Thus the use of different templates would result in different deliverables which may cause confusion and uncertainty to the stakeholders who have to work with the deliverables from NED and would have an impact on the project reviewing aspect of quality, internally and externally.

Continuous Improvement category results

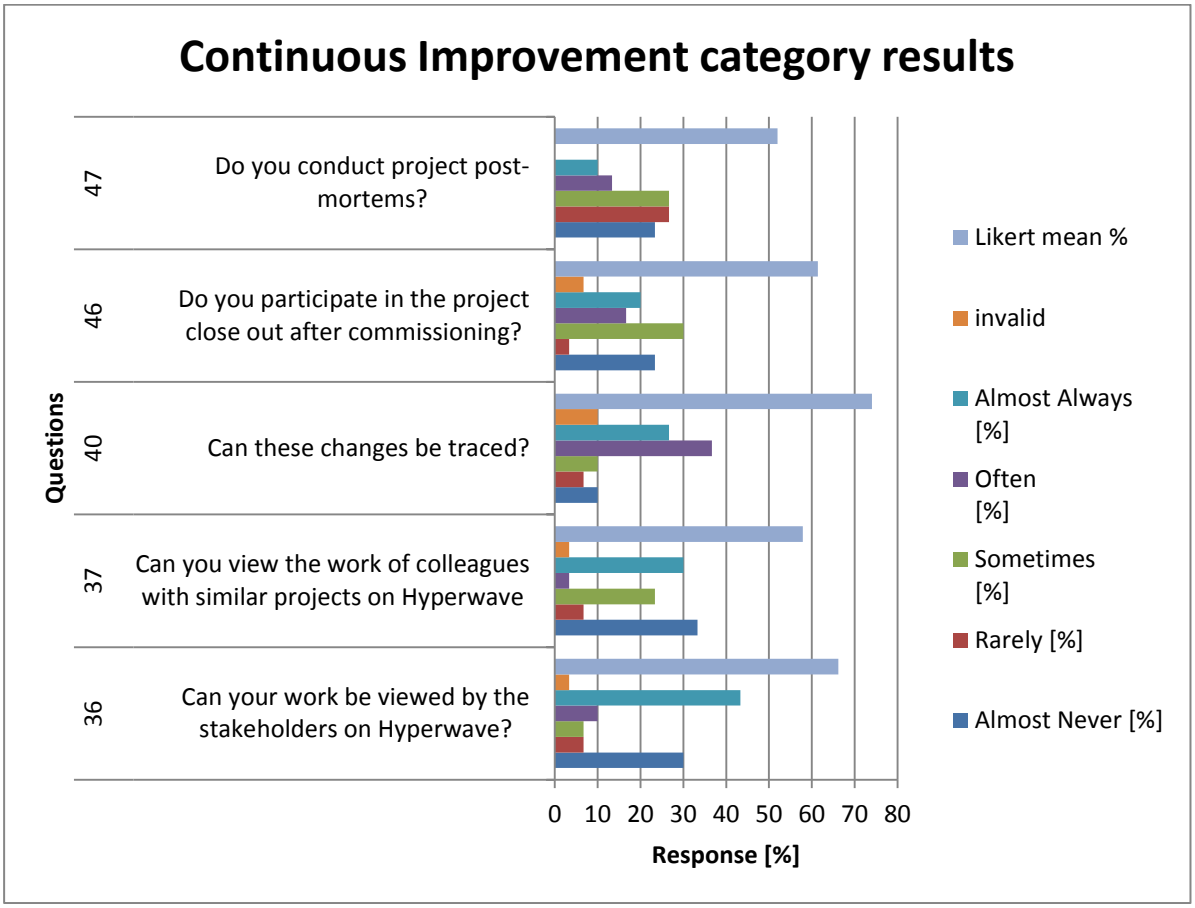


Figure 9: Graphical representation of Continuous Improvement category results

In this category it was noticed that the level of adherence to Eskom's requirements for quality assurance was generally moderate to low as the Likert mean percentage on most questions lay between 60% and 75% where question 37 and 47 indicated a low level of adherence. As discussed in the Documentation Management category results paragraph, the inaccurate use of Hyperwave had a negative impact on the continuous improvement aspects of quality. More attention needed to be focused on the continuous improvement aspect.

Continuous improvement was also affected by how the project post mortems were conducted. Conducting post mortems on projects gives the engineers and all stakeholders an opportunity to learn from the experiences in a project with the intention of avoiding challenges faced and continuing with the positive in the projects to follow.

Project Reviews category results

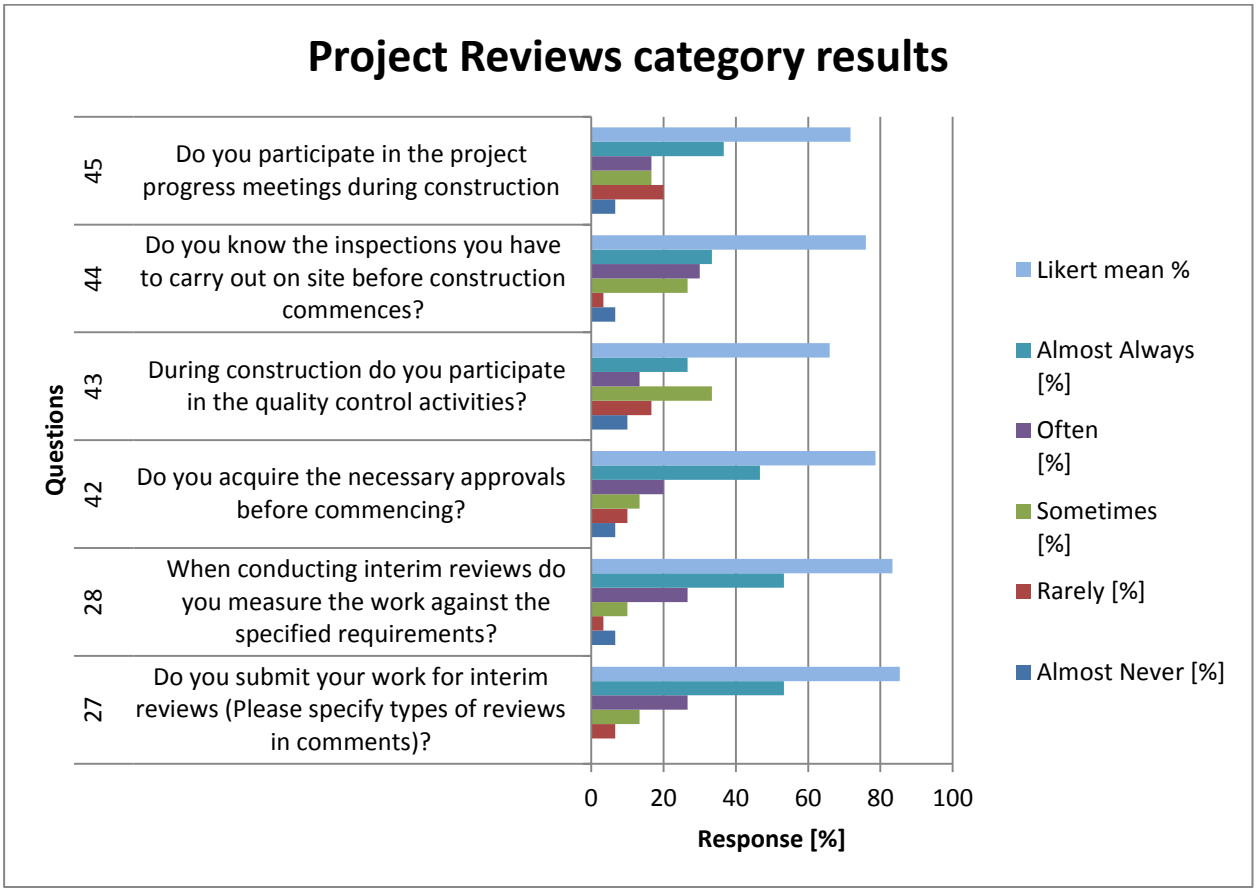


Figure 10: graphical representation of Project Reviews category results

In general, the results in this category indicated that there was a high level of adherence to Eskom's process and the requirements for quality assurance. This was indicated by the Likert mean percentages that are above 76% on all questions except for question 43 and 45 that indicated a moderate level of adherence. These results indicated that sufficient effort was put in reviewing (in the form of quality control) projects internally. However once the project was at an advance stage not much effort was put in the reviewing.

This had an impact on the continuous improvement aspects of quality as the opportunity to witness and relate the design with the practical implementation was lost. The opportunity of clarifying the design to the person implementing it was also lost and may have resulted in the stakeholders not meeting the design specification.

4.4.2. Interviews

From the questionnaire results it was indicated that there were certain aspects of quality Management that needed to be addressed. This was based on the questions posed on the questionnaire relative to the Eskom's requirements for quality management which was proven to be in line with the industry standards.

In the attempts to determine other factors not tested by the questionnaire which may result in the projects being returned to NED, interviews with seniors and juniors were conducted. The results of these interviews are discussed in this section. These interviews were conducted as specified in paragraph 3.6 of this document.

4.4.2.1. Results - Seniors interview

Due to the remote location of some of the seniors and the unavailability of the seniors the interviews were conducted over the telephone.

In the interview two questions were asked

Did your section or group experience rework?

What contributed to the need for rework?

The participants were more than willing to talk.

In total 7 seniors were interviewed each representing either a different region or group within the NED department. Refer to paragraph 4.1 for a list of senior interviewed and their area of expertise.

A thematic data analysis method was used to analyse the data from the seniors' interviews. When categorising the data the preconceived categories (those identified when analysing root cause analysis data see paragraph 4.2 were used. From the interview the categories that dominated were the Management/Leadership commitment to quality followed by the Customer and supplier relations. Refer to Table 8

Table 8: Categories of factors affecting quality that rose in seniors' interview

Identified Category	Results
Customer and suppliers relations	Raised in 6 interviews
Documentation and Information	Raised in 5 interviews
Management/Leadership Commitment to Quality	Raised in 5 interviews
Project Management	Raised in 4 interviews
Project Reviews	Raised in 4 interviews
Experience	Raised in 4 interview
Template	Raised in 3 interview
Processes and Procedure	Raised in 3 interviews
Training	Raised in 3 interview
Unforeseen	Raised in 2 interview

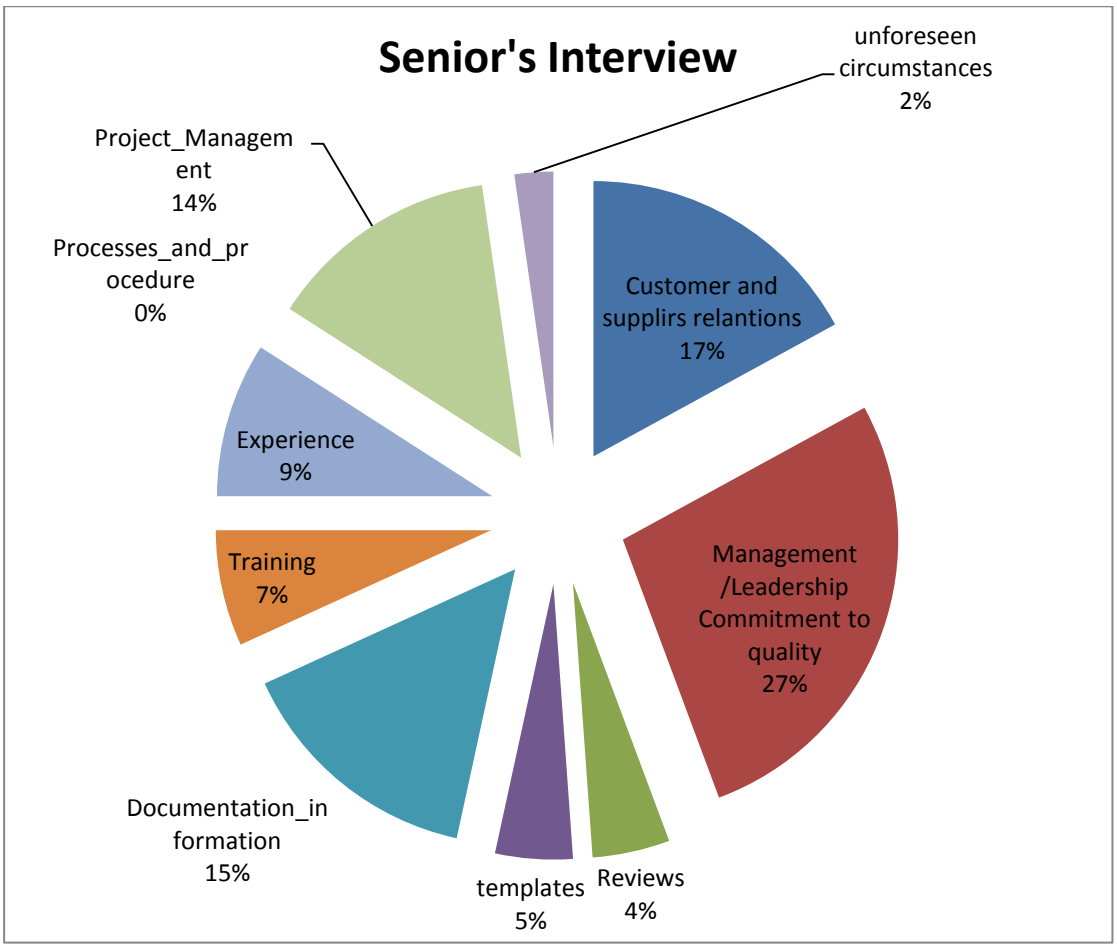


Figure 11: Seniors interview Pie Chart

Figure 11 indicates the categories and ranks them in order of appearance, From Figure 11 it can be noted that even though the stakeholder's management category was raised by most interviewees (most emphasis was made on the category of management/leadership).

4.4.2.2. Results – Juniors' Forum

The junior's interview was conducted as a group brainstorming session where all the groups in NED were represented by at least one member. The invitation to participate was extended to all personnel in NED. Two of the personnel who were interested in participating were not able to attend the brain storming session. For these personnel separate interview sessions were scheduled and conducted.

The data from the juniors' forum were analysed using the thematic data analysis method. The identified categories, in the thematic analysis, were ranked in order of appearance and were than represented in a pie chart form. Refer to Figure 12.

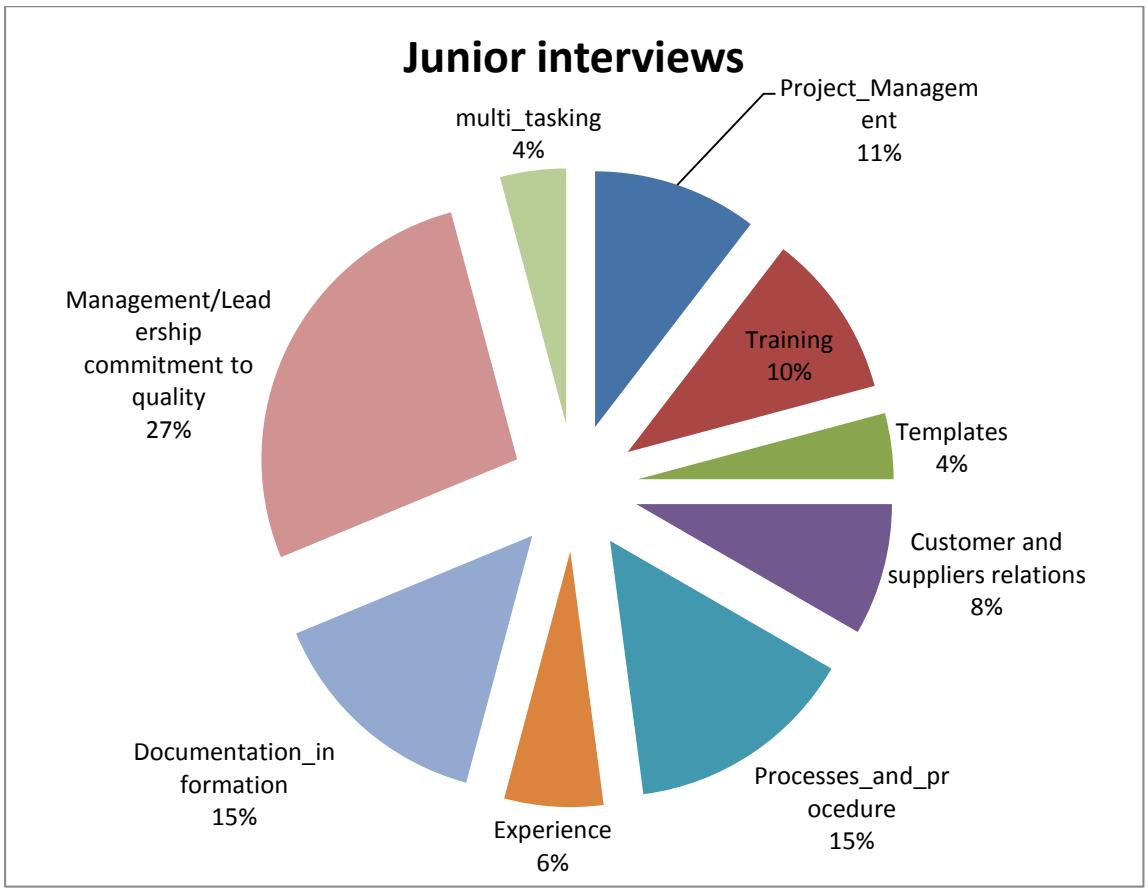


Figure 12: Juniors forum Pie chart

4.4.2.3. Discussion of major category

In this section only those categories that scored above 10% on either the senior's interview or the juniors interviews are discussed.

From the senior's interviews the categories identified were:

Management/Leadership commitment to quality	27%
Customer and suppliers relations	17%
Documentation and information	15%
Project Management	14%

From the junior's interviews the categories identified were:

Management/Leadership commitment to quality	27%
Processes and procedure	15%
Documentation and information	15%
Project Management	11%
Training	10%

Management/Leadership commitment to quality

The data collected in this category was identified as the major contributor to the rework in both the senior's interviews and the junior forums. From this category one notices that some of the decisions (such as project approval, engineers site visits, project allocations, time allocation to projects and training approvals) taken by managers jeopardised the quality of the project.

The technical content of a project are approved by the Technical Evaluation Forum (TEF) and the concerns raised is that the forum did not look at all aspects of a project when approving project, some projects due to business interest were pushed through the process even though they did not meet the requirements. This violated the process for managing quality in the project cycle as described in (Rabie 2013) which indicates that the project cannot be moved to the next phase if the requirements of the previous phase have not been addressed

It was also evident from the interviews that it was also the managers who allow the projects to skip processes due to business requirements. The decisions taken by managers, that prevented the engineers from participating in the stakeholders' management process, had an impact on the quality of a project. This showed lack of commitment to quality from the managers and violated the requirement specified in section 6.9.4 in (Keyser 2012). Even though the managers were not interviewed to verify this concern, this concern can be considered to be valid since it is also gathered from the seniors who act as a link between the managers and the engineers.

The other concerns raised during the interviews was the fact that there was an information gap between the managers and the personnel where the personnel did not know the direction the department was taking and the changes made to the business requirements. These changes in business requirements also had an impact on the project outcome as the business requirements also act as input information in designs.

Customer and suppliers relations

The information in the literature survey in paragraph 2.4 of this document also showed that the interaction between the designer and the Customer played a vital role in ensuring quality and project success. Therefore the customer and the suppliers needed to know and understand their role in the project in order to provide constructive input to the project.

The seniors' interviews indicated some concerns regarding the customers and suppliers identification. It was also indicated that employees from other departments or groups sometimes did not know their responsibility. This resulted in task duplication or task neglecting. This was also an indication that managers are not doing enough to ensure that their personnel

understand their target and boundaries of work and are competent enough to carry out this work.

The data collected in this category suggests that the personnel just conducted what they perceived as their part of the work and once they were done they didn't seem to be bothered. This was an indication of lack of commitment to quality management by the personnel. It is also showed that the communication and information sharing sessions with the NED customers and suppliers were arranged but the decision made by management limits the participation of the engineers. This did not support the principle of having the managers commit to quality (ISO 2015) and (Keyser 2012).

Documentation and information

The information gathered in this category indicated that, in general projects were inherited from other engineers and during the process of handing over not all the information was made available to the new engineer, at times the available information was not accurate, and this problem was also evident in the information transfer among colleagues in the different groups within NED. This meant that the new engineer did not have sufficient or accurate design input information to see the project to the end. Even the existing drawings did not have accurate information.

Paragraph 2.3 of the literature survey indicates that a criterion of measuring quality is by meeting the client's requirements. This may prove to be difficult with insufficient information. In some instances an engineer had to work with only an inaccurate drawing to re populate the other related documents to be included in the design hand over package. During the data repopulation original input information was misrepresented and led to quality being affected. This meant that the engineer were able to effectively set the requirement and design parameters. According to (Moodley 2012) in design review should focus on the designs ability to meet the customer's requirements and the identified design parameters.

Even if there were changes to be made to the design the engineer would not be in a better position to implement such changes effectively, as he may not have the information that clearly defines the problem.

Based on this information, it is concluded that the quality management processes were not fully addressed

Processes and Procedures

The data under the process and procedure category of this thematic analysis indicated that during construction changes were made on site without following the proper engineering change procedures. From the data in this category it can be noted that, projects were also moved to the next level phase without going for technical evaluation (gate reviews) by the relevant technical evaluation forum. It was also indicated that at times projects had to be presented at DRA phase technical gate review without being supported at the Technical Evaluation Forum (TEF). This shows that throughout the project life cycle the Eskom processes were not always followed and the available tool used to manage the process (ACNAC) was not fully utilised. Besides the slacking in following the processes there were also concerns raised about the processes not being known.

The literature survey in paragraph 2.5 indicated that the generic Eskom processes for ensuring quality are compatible with the industry standards. Thus failure to adhere to the Eskom's processes and procedures may result in inferior quality projects. According to (Keyser 2012)it is the responsibility of the Discipline manager to ensure that the employees are aware of the applicable company QM processes and procedures.

Project Management

The data collected in this category indicated that projects that went past the design stage did not start construction at the times that they were planned to start. From the interview there was no time specified. However from the root cause analysis some of the project took as long as 5 years before construction commenced. By the time construction commenced the conditions had changed and the technology may also have changed and would no longer suite the original design. It was not clear from the available data what the cause of the delay in projects execution was but it was evident that at times project management would purchase material that had not been specified in the design. One can also gather that the project process was not managed from the initial stages and thus the project managers act only as execution managers.

According to the Eskom document 240-64014170 (Rabie 2013) the project manager is responsible for managing the project from the initial stages through to construction and hand over. In order for a project to be successful the project process needed to be managed at all stages.

Training

This category was raised in both the seniors and the junior's interview where the primary concerns were related to information sharing among colleagues and development of employees. The senior's interviews indicated that the training opportunities were made available to the personnel and it was the responsibility of the personnel to book themselves into to these trainings but the personnel did not book themselves on those training. This is an indication that Eskom support continuous improvement and training.

4.5. Results - Validating suggestions on how to improve the NED processes Document

Based on the factors identified in the previous chapters, suggestions on how to improve the NED's QM system (specifically the NED Processes Document) were made. In order to validate if the suggestions made to improve the NED Processes Document would be able to resolve the quality factors identified in this study an interview session was conducted with an ECSA registered senior engineer who conducted research on project system compliance and project performance in distribution and had a holistic understanding of the NED processes. An interview Request was sent to the senior a week prior to meeting where the requests also explained the intention of the interview and the expected outcomes

The Current NED Processes Document, the suggestions for improvement, the findings from the factors affecting quality in NED and the interview evaluation form were sent to the interviewee.

The interview was held at the seniors' office and the comments were written on the prepared interview form (refer to *Appendix A6: Interview with quality Expert*).

From the interview it was found that the suggestions made were sufficient to resolve most of the department's quality issues however, for each field identified above more investigation needed to be done in order to fulfil the suggestions in each field. For example a thorough investigation needed to be done to determine how the different processes in different groups integrated and what impact it had on the service provided to the customer.

4.6. Summary of the Chapter

The results from the questionnaire in general indicated that there was a high level of adherence to the inadequately designed QM systems. When calculating the overall mean the level of adherence was above 75%. However there were areas that still required attention specifically in the category of continuous improvement and that of the deliverables and templates. There were

also other quality assurance factors that needed to be improved in other categories with results showing a high level of adherence. These aspects include:

- Completion of designs with insufficient input information.
- The effective use of Hyperwave.
- Inclusion/participation of NED as a supplier in other departments activities.

The seniors and juniors interviews gave more detailed on the categories that had already been identified in the root cause analysis and the questionnaire, refer to Figure 11 and Figure 12. From these figures management's commitment to quality was identified as the biggest contributor to the NED department's rework.

The interviews' information indicated that the problem areas identified in the questionnaire were the same as those identified in the interviews.

When reviewing the NED Processes Document it was evident that not all the categories raised in this study were addressed by the document. Instead of describing the processes to be followed to address the departmental concerns, the NED Processes Documents in general raised concerns, some similar to those identified in this study, but provided little details as to how these concerns were addressed or make reference to the information that indicated how these concerns were addressed.

The drafted NED Processes Document was compiled in 2013 and due for revision in 2014 which was not done it was also advised that the revision should address the concerns raised in this study and make reference to the solutions processes.

The results have been discussed in this chapter and conclusions based on the findings are reported in the following chapter (Chapter five)

5. CHAPTER FIVE - Conclusion and Recommendation

5.1. Conclusion

This research had the aim of determining the primary cause for NED rework. For this research a supposition was made that a lapse in quality management was at the root of having projects returned to NED for rework. The research attempted to prove this supposition and provide a solution by answering the following questions:

- *Objective 1: Was poor quality management the cause of the identified projects being returned?*
- *Objective 2: Were the current Eskom Quality Management systems adequate to have prevented reworks?*
- *Objective 3: To what extent were the Eskom Quality Management systems adhered to?*
- *Objective 4: What can be done to improve the Eskom Quality Management system in NED?*

5.1.1. Was poor quality management the cause of the identified projects being returned?

In an attempt to answer this question a root cause analysis form was drafted to be completed by the engineers responsible for the identified project. This exercise was viewed by some engineers as a tedious paper exercise. This could have had an impact on the accuracy of the data collected. However, the researcher had to review the submitted root causes and the exercise was completed successfully and indicated that there were different root causes for the rework in each project. All the root causes were related to at least one of the ISO 9000 Quality Management principles. This finding supported the supposition that lack of quality management was the key reason for the rework.

5.1.2. Were the current Eskom Quality Management systems adequate to have prevented reworks?

The answer to this question was derived from a literature survey. The survey indicated that the company does have quality management procedures in place which are in par with the industry standards. However, the quality management procedures that were competitive with the industry standards were generic and only addressed systems till the departmental manager level. Based on the industry standards and the Eskom generic QM system in order for the QM system to be adequate a division specific QM system needs to be in place. The exercise of validating the document that addresses the departmental QM systems (NED Processes

Document) found that the document was not adequate to prevent rework by NED. Thus making the entire QM system inadequately designed. The author recommends that the NED Processes Document be revised in order to ensure work is done correctly the first time.

5.1.3. To what extent were the Eskom Quality Management systems adhered to?

This section was categorised into two studies. The study that measured the level of adherence of the NED employees to the inadequately designed company standards was in the form of a questionnaire. While the study to identify additional factors that influence the need for NED rework was conducted in a form of seniors and juniors interviews. The questionnaire and the interview concentrated on the personnel at operational level and excluded the management level. The only representation at the management level was that of the seniors who act as a liaison between the ground personnel and the line management. The study, in the form of questionnaire, indicated a high level of adherence to the inadequately designed QM systems where the overall Likert mean percentage was above 75%. Note that the questionnaire did not measure the contribution of Management/Leadership commitment to quality when determining the level of adherence. The interviews indicated flaws in the QM system which needs to be addressed. Management/Leadership commitment indicated to have a greater role in affecting project quality, where mainly the decisions made by management did not support the quality management system. It was also the responsibility of management to ensure that the QM systems of the company, specifically the divisional QM system were in place and that all employees were aware of such systems and adhered to them. However the fact that the division QM system was in place, not approved and not known by the bulk of engineers did not support the requirement for good quality management system. This proves that the quality management systems were not adequately applied.

Since management's commitment to quality was the main factor that affected quality, it was advisable for the researcher to conduct a study on what was causing management to have little commitment to the divisions QM system. This would have helped the researcher to make more accurate suggestions on how to prevent the rework and improve the departments QM system

5.1.4. What can be done to improve the company's QM system in NED?

Suggestions on how to improve the NED's QM system based on the flaws identified were made and discussed with an ECSA registered senior engineer to determine its potential to improve the NED department's QM system. The suggestions made were agreed to by the senior with comments. (Refer to *Appendix A6: Interview with quality Expert* for comments). However the review indicated that the suggested method of implementation needs to be explained in more depth to ensure effective implementation.

This research created a wide awareness of the identified problems and the potential solutions, and an overall eagerness to progress was noted by the researcher.

5.2. Recommendation and generalisation

It was shown that a key contributor to the quality problems of the department was lack of leadership and commitment by management, and it is thus recommended to conduct a research that would determine why management had little commitment to the company's QM system[1]. Once the QM system was effectively running it can be adopted into the other operating units. It is proposed that the findings of this study may be generalised to be applicable to other divisions of Eskom, and may also be useful to other departments in other operating units to develop or improve their departmental QM systems.

1. Footnote: During this study my supervisor commented that this is a unique situation where the reporting staff is pushing for better quality management. It is usually management who are trying to impose quality management on the subordinate staff!

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Appendix A1: Root cause analysis Form

Table A-1: Root cause Analysis form

[Type title in this block]	
Substation Name	
Date of finding	
Name of report compiler	

Introduction

[Briefly Indicate relevant background information including the motivation for the initial project, information on the original design, DHO contents and processes used]

Sequence of events

Observation

[Discuss the sequence of events and other information gathered during the investigation]
[Discuss any other findings that may not be related to the investigation but need to be addressed]

Causal analysis

[demonstrate the method used to conduct the root cause analysis indicating how the incident occurred]
[Indicate contributing factors]
[indicate root cause]

Recommendations

[Indicate recommend corrective actions and actions to be taken to prevent such occurrences]

Summary and Lessons learnt

[Describe in short what happened concentrating on main events, factors leading to root cause and the corrective action this must be short ±150 words]

Appendix A2: Questionnaire Forms

Table A-2: Questionnaire forms

Dear Participant,

I invite you to participate in a research study entitled: “A quality assurance system to improve the performance of Eskom’s Network Engineering and Design Department” focusing mainly on the North West Operating Unit.

I am currently enrolled in the Masters of Engineering – Development and Management Engineering program at the North West University. I am in the process of writing my Master’s Thesis. The purpose of the research is to determine the cause of having designs returned to NED for review when they are at a construction stage.

The enclosed questionnaire has been designed to collect information on the employees’ level of adherence to the available Eskom quality procedures.

Your participation in this study will assist in the success of this study and will in turn contribute to ensuring that some of the quality issues affecting your work are addressed.

Even though you are urged to participate and answer all questions honestly, your participation in this research project is completely voluntary, you may decline altogether, or leave blank any questions you don’t wish to answer. There are no known risks to participation beyond those encountered in everyday life. Your responses will remain Anonymous and you need not write your name or any identifying information on the questionnaire. Your participation in this study will therefore not affect your relationship with the employer.

If you agree to participate in this project, please answer the questions on the questionnaire as best as you can. It should take only a 15minutes to complete. Please return the questionnaire as soon as possible to Ayanda Nzo by email (nzoab@eskom.co.za) or delivery to office C1, 22 Golden Avenue, Townlands Klerksdorp, 2571

If you have any questions about this project, feel free to contact Mr A.B Nzo at 073 058 5110 or 018 464 6660. Information on this study will be available on Hyper-wave and may be used for any further studies related to this one.

Thank you for your assistance.

Yours Sincerely,

Ayanda Bapetuxolo Nzo

Please Mark with an X in the appropriate block

Designation:	Engineer	1	Drafts person	2	Senior	3		
Section:	Primary Plant	1	Control plant	2	Drawing	3	MV	4
Period of service:	Less than 1 year.	1	More than 1year	2	More than 5years	3		

Please read the questions below and indicate with an X in the appropriate block which indicates the frequency in which you conduct the activity indicated in the question from a scale of 1 to 5 where 1 indicates Never and 5 indicates almost always.

If you feel you need to elaborate on your answer please indicate the question number and your comment in the comment section provided at the end of the questionnaire.

Q. No.	*Question*	*Almost Never*	*Rarely*	*Sometimes*	*Often*	*Almost Always*
1	Do you complete your part of the project without sufficient input information?	1	2	3	4	5
2	Do you conduct a literature study on all projects?	1	2	3	4	5
3	Do you Identify stake holders at the beginning of the project before working on the project?	1	2	3	4	5
4	Do you provide stakeholders with sufficient information prior to requesting their requirements?	1	2	3	4	5
5	Do you define project boundaries in the preliminary stage?	1	2	3	4	5
6	Do you confirm project boundaries with the stakeholders?	1	2	3	4	5
7	Do you allow other stakeholders besides the user to compile requirements?	1	2	3	4	5
8	Do you analyse the project requirements?	1	2	3	4	5
9	Do you verify the project requirements?	1	2	3	4	5
10	Do you validate the project requirements?	1	2	3	4	5
11	Do you allow stakeholders to participate in requirements reviews?	1	2	3	4	5
12	Are you able to trace the requirements during the progress of the project?	1	2	3	4	5

Q. No.	*Question*	*Almost Never*	*Rarely*	*Sometimes*	*Often*	*Almost Always*
13	Do you take ownership of the clients' requirements?	1	2	3	4	5
14	Do you take ownership of the user's requirements?	1	2	3	4	5
15	Do you take ownership of the internal stakeholder's requirements?	1	2	3	4	5
16	Do you refer to Eskom's standards for technical guideline when completing projects?	1	2	3	4	5
17	Do you adhere to Eskom's standards for technical guideline?	1	2	3	4	5
18	Do you know the standards that are applicable to your work?	1	2	3	4	5
19	Do you know where to get the standards?	1	2	3	4	5
20	Do you have access to these standards?	1	2	3	4	5
21	Do you use the latest available copy of the standard?	1	2	3	4	5
22	Do you have access to the applicable NED templates?	1	2	3	4	5
23	Do you use the Volumes templates for your projects?	1	2	3	4	5
24	Do you use the PDD/DDD templates for your projects?	1	2	3	4	5
25	Do you use other available templates (please specify under comments)?	1	2	3	4	5
26	Do you follow the checklists provided as guidance for completing projects?	1	2	3	4	5
27	Do you submit your work for interim reviews (Please specify types of reviews in comments)?	1	2	3	4	5
28	When conducting interim reviews do you measure the work against the specified requirements?	1	2	3	4	5
29	Do you follow the work flow process as guided by ACNAC?	1	2	3	4	5
30	Do you commence to the next level approval when the previous level has not yet been approved?	1	2	3	4	5
31	Do you complete the ACNAC forms in simultaneously with the project progress?	1	2	3	4	5
32	Do you have access to Hyperwave documentation control system?	1	2	3	4	5
33	Do you use the Hyperwave documentation control system?	1	2	3	4	5

Q. No.	*Question*	*Almost Never*	*Rarely*	*Sometimes*	*Often*	*Almost Always*
34	Do you save work in progress on Hyperwave?	1	2	3	4	5
35	Do you save completed work on Hyperwave?	1	2	3	4	5
36	Can your work be viewed by the stakeholders on Hyperwave?	1	2	3	4	5
37	Can you view the work of colleagues with similar projects on Hyperwave	1	2	3	4	5
38	**If there are changes in the project at an advanced stage:**	1	2	3	4	5
39	Do you record these changes?	1	2	3	4	5
40	Can these changes be traced?	1	2	3	4	5
41	Do you inform all the stakeholders of the changes?	1	2	3	4	5
42	Do you acquire the necessary approvals before commencing?	1	2	3	4	5
43	During construction do you participate in the quality control activities?	1	2	3	4	5
44	Do you know the inspections you have to carry out on site before construction commences?	1	2	3	4	5
45	Do you participate in the project progress meetings during construction	1	2	3	4	5
46	Do you participate in the project close out after commissioning?	1	2	3	4	5
47	Do you conduct project post-mortems?	1	2	3	4	5
48	When projects are cancelled are you notified	1	2	3	4	5

If you have any comments please indicate the comments in the space provided below

Q. No.	**Comment**
25	
27	

Appendix A3: Questionnaire analysis raw data

Table A-3: Questionnaire analysis raw data

Q. No.	*Question*	*Almost Never [%]*	*Rarely [%]*	*Sometimes [%]*	*Often [%]*	*Almost Always [%]*	invalid [%]	Likert mean [%]	mean	Std deviation	Category
1	Do you complete your part of the project without sufficient input information?	6,7	26,7	30,0	20,0	16,7	0,0	62,7	3,13	1,196	Input information and requirements
2	Do you conduct a literature study on all projects?	10,0	10,0	23,3	30,0	23,3	3,3	69,7	3,48	1,271	Input information and requirements
5	Do you define project boundaries in the preliminary stage?	0	6,7	16,7	33,3	43,3	0,0	82,7	4,13	,937	Input information and requirements
8	Do you analyse the project requirements?	0	3,3	0,0	13,3	80,0	3,3	95,2	4,76	,636	Input information and requirements
9	Do you verify the project requirements?	0	6,7	0,0	36,7	56,7	0,0	90,0	4,50	,630	Input information and requirements
10	Do you validate the project requirements?	0	6,7	20,0	23,3	43,3	6,7	82,1	4,11	,994	Input information and requirements
16	Do you refer to Eskom's standards for technical guideline when completing projects?	0	0	0	13,3	86,7	0,0	97,3	4,87	,346	Input information and requirements
17	Do you adhere to Eskom's standards for technical guideline?	0	0	0	23,3	76,7	0,0	95,3	4,77	,430	Input information and requirements
12	Are you able to trace the requirements during the progress of the project?	3,3	6,7	13,3	30,0	43,3	3,3	81,4	4,07	1,100	documentation Management
18	Do you know the standards that are applicable to your work?	0	0	0	20,0	80,0	0,0	96,0	4,80	,407	documentation Management
19	Do you know where to get the standards?	0	0	3,3	20,0	76,7	0,0	94,7	4,73	,521	documentation Management
20	Do you have access to these standards?	0	0	3,3	16,7	80,0	0,0	95,3	4,77	,504	documentation Management
21	Do you use the latest available copy of the standard?	0	0	10,0	23,3	63,3	3,3	91,0	4,55	,686	documentation Management
32	Do you have access to Hyperwave documentation control system?	10,0	6,7	0,0	13,3	70,0	0,0	85,3	4,27	1,363	documentation Management
33	Do you use the Hyperwave documentation control	10,0	10,0	26,7	26,7	23,3	3,3	69,0	3,45	1,270	documentation Management

Q. No.	Question	Almost Never [%]	Rarely [%]	Sometimes [%]	Often [%]	Almost Always [%]	invalid [%]	Likert mean [%]	mean	Std deviation	Category
	system?										
34	Do you save work in progress on Hyperwave?	50,0	13,3	13,3	3,3	20,0	0,0	46,0	2,30	1,601	documentation Management
35	Do you save completed work on Hyperwave?	30,0	6,7	10,0	10,0	40,0	3,3	64,8	3,24	1,766	documentation Management
39	Do you record these changes?	6,7	13,3	6,7	26,7	43,3	3,3	77,9	3,90	1,319	documentation Management
3	Do you Identify stake holders at the beginning of the project before working on the project?	0,0	3,3	3,3	13,3	80,0	0,0	94,0	4,70	,702	stakeholders management
4	Do you provide stakeholders with sufficient information prior to requesting their requirements?	0	0	3,3	23,3	70,0	3,3	93,8	4,69	,541	stakeholders management
6	Do you confirm project boundaries with the stakeholders?	3,3	10,0	6,7	30,0	46,7	3,3	82,1	4,10	1,145	stakeholders management
7	Do you allow other stakeholders besides the user to compile requirements?	0	0	13,3	36,7	43,3	6,7	86,4	4,32	,723	stakeholders management
11	Do you allow stakeholders to participate in requirements reviews?	3,3	10,0	0,0	30,0	46,7	10,0	83,7	4,19	1,145	stakeholders management
13	Do you take ownership of the clients' requirements?	0	3,3	3,3	20,0	73,3	0,0	92,7	4,63	,718	stakeholders management
14	Do you take ownership of the user's requirements?	0	0	3,3	30,0	63,3	3,3	92,4	4,62	,561	stakeholders management
15	Do you take ownership of the internal stakeholder's requirements?	0	0	6,7	26,7	63,3	3,3	91,7	4,59	,628	stakeholders management
41	Do you inform all the stakeholders of the changes?	6,7	10,0	16,7	16,7	46,7	3,3	77,9	3,90	1,319	stakeholders management
48	When projects are cancelled are you notified	33,3	16,7	26,7	13,3	10,0	0,0	50,0	2,50	1,358	stakeholders management
22	Do you have access to the applicable NED templates?	3,3	3,3	16,7	20,0	56,7	0,0	84,7	4,23	1,073	deliverables and templates
23	Do you use the Volumes templates for your projects?	43,3	3,3	20,0	0,0	30,0	3,3	57,9	2,90	1,839	deliverables and templates

Q. No.	*Question*	*Almost Never [%]*	*Rarely [%]*	*Sometimes [%]*	*Often [%]*	*Almost Always [%]*	invalid [%]	Likert mean [%]	mean	Std deviation	Category
24	Do you use the PDD/DDD templates for your projects?	16,7	3,3	3,3	0,0	63,3	13,3	81,5	4,08	1,647	deliverables and templates
25	Do you use other available templates (please specify under comments)?	53,3	6,7	13,3	6,7	13,3	6,7	42,9	2,14	1,533	deliverables and templates
26	Do you follow the checklists provided as guidance for completing projects?	20,0	6,7	10,0	26,7	36,7	0,0	70,7	3,53	1,548	deliverables and templates
29	Do you follow the work flow process as guided by ACNAC?	6,7	16,7	26,7	23,3	26,7	0,0	69,3	3,47	1,252	deliverables and templates
30	Do you commence to the next level approval when the previous level has not yet been approved?	43,3	6,7	16,7	20,0	10,0	3,3	49,0	2,45	1,502	deliverables and templates
31	Do you complete the ACNAC forms in simultaneously with the project progress?	10,0	26,7	26,7	20,0	10,0	6,7	58,6	2,93	1,184	deliverables and templates
36	Can your work be viewed by the stakeholders on Hyperwave?	30,0	6,7	6,7	10,0	43,3	3,3	66,2	3,31	1,795	Continuours improvement
37	Can you view the work of colleagues with similar projects on Hyperwave	33,3	6,7	23,3	3,3	30,0	3,3	57,9	2,90	1,676	Continuours improvement
40	Can these changes be traced?	10,0	6,7	10,0	36,7	26,7	10,0	74,1	3,70	1,295	Continuours improvement
46	Do you participate in the project close out after commissioning?	23,3	3,3	30,0	16,7	20,0	6,7	61,4	3,07	1,464	Continuours improvement
47	Do you conduct project post-mortems?	23,3	26,7	26,7	13,3	10,0	0,0	52,0	2,60	1,276	Continuours improvement
27	Do you submit your work for interim reviews (Please specify types of reviews in comments)?		6,7	13,3	26,7	53,3	0,0	85,3	4,27	,944	Project reviews
28	When conducting interim reviews do you measure the work against the specified requirements?	6,7	3,3	10,0	26,7	53,3	0,0	83,3	4,17	1,177	Project reviews
42	Do you acquire the necessary approvals before commencing?	6,7	10,0	13,3	20,0	46,7	3,3	78,6	3,93	1,307	Project review

Q. No.	*Question*	*Almost Never [%]*	*Rarely [%]*	*Sometimes [%]*	*Often [%]*	*Almost Always [%]*	invalid [%]	Likert mean [%]	mean	Std deviation	Category
43	During construction do you participate in the quality control activities?	10,0	16,7	33,3	13,3	26,7	0,0	66,0	3,30	1,317	Project review
44	Do you know the inspections you have to carry out on site before construction commences?	6,7	3,3	26,7	30,0	33,3	0,0	76,0	3,80	1,157	Project review
45	Do you participate in the project progress meetings during construction	6,7	20,0	16,7	16,7	36,7	3,3	71,7	3,59	1,376	Project review
	Average							76,8			

Legend and colour coding explanation

	Negative question										
	High level of adherence										
	Moderate level of adherence										
	Low level of adherence										

Appendix A4: Seniors' interview raw data

Table A-4: Seniors interview raw data

Statement	Category
Not enough support from peers	stakeholders_management
gap in interdepartmental integration	stakeholders_management
People doing out work on our behalf	stakeholders_management
Other peoples mistakes require our input for correction	stakeholders_management
Not participating in site or hand over meeting	stakeholders_management
trying to please others	stakeholders_management
Not all stakeholders are involved in the project	stakeholders_management
Not all stakeholders are active	stakeholders_management
Communication and interaction with stakeholders is lacking	stakeholders_management
poor communication between engineers and drafts persons	stakeholders_management
engineers don't know drafting department processes	stakeholders_management
drafts persons do not have basic electrical knowledge	stakeholders_management
Engineers do not help drafts person to understand the project.	stakeholders_management
communication between departments	stakeholders_management
other departments doing other departments duties	stakeholders_management
management not providing enough time to complete the work	Management
In general quality is not managed	Management
time allocation for project is not enough	Management
time allocation for project is not enough depending on work load	Management
TEF should measure and evaluate the correct aspects of the project not the generic	Management
TEF should test all elements	Management
Design monitoring tool that allows you to track projects are not used.	Management
Things discussed in meetings should be enforced	Management
TEF does not have all information when making decision	Management
Lack of design management systems in place	Management
Design management systems are not enforced.	Management
end up being under pressure and submit substandard designs	Management
We are not all Moving together (information gap between levels)	Management
we need to talk the same language (direction and vision)	Management
support from managers in engaging other departments interlinked to NED	Management
rushed to complete project by managers	Management
Dictatorship from Managers affecting quality and plan of engineers	Management
Engineers are restricted in applying their minds	Management
Managers making technical decisions overriding seniors	Management

Demoralised personnel	Management
Lack of funding on projects results in changing dictions	Management
continuous change in rolling plan	Management
engineers are limited in participating in progress meetings by managers	Management
money constraints	Management
Post mortems not done	Reviews
Design reviews are not done	Reviews
we need a design review after TEF	Reviews
Peer checking is not effectively done	Reviews
effectiveness of templates	Templates
accurate use of templates	Templates
information on either template is the same	Templates
Templates should not be a problem as contents are the same	templates
lack of knowledge	Documentation_information
engineers design without thorough investigation	Documentation_information
designs conducted without enough input information	Documentation_information
assumptions are made and not verified (e.g. Earthmat in good condition)	Documentation_information
Input information is not always accurate	Documentation_information
Implementation plan changes	Documentation_information
implementation plan not accurate	Documentation_information
Engineers change their mind	Documentation_information
insufficient input information provided	Documentation_information
engineer changing their mind	Documentation_information
existing drawings are not accurate	Documentation_information
scope requirements are not fixed and not always in writing	Documentation_information
survey input information not accurate	Documentation_information
people don’t book for training	Training
Training is done as an on job training	Training
technical sessions not conducted	Training
Technology change not known to engineer	Training
Lack of training but team is willing to find out on their own	Training
No training on HV line design is provided	Training
assume work will take you a shorter time than it actually will	Experience
Personnel don’t have enough experience	Experience
Lack of experience	Experience
Experience is lacking	Experience
The more experience the less mistakes	Experience
department as a collective is on a learning curve	Experience
uncertainties	Experience
Engineers are on a learning curve	Experience
ACNAC process is not fully utilised	Processes_and_procedure

Eskom processes not followed Projects taken to IC without TEF	Processes_and_procedure
Material being purchased before the budget quote is approved	Project_Management
Project schedules are not known	Project_Management
Project Planning is not done properly	Project_Management
Project Management only participate when project is at construction phase.	Project_Management
Schedules not adhered.	Project_Management
No project co-ordination to meet deadlines.	Project_Management
Projects constructed later than planned	Project_Management
Project management managing projects at a late stage	Project_Management
No proper schedule	Project_Management
Purchase of material not according to design	Project_Management
design construction starts late	Project_Management
interdependent projects but different contractors appointed	Project_Management

Appendix A5: Juniors' interviews raw data

Table A-5: Juniors interview raw data

Statement	Category
duration of projects and late implementation	Project_Management
Suppliers information changed (what was purchased does not fit application)	Project_Management
when Contractors are changed there is not enough time to evaluate accurately	Project_Management
Delay in implementation	Project_Management
waiting for a long time before implementation by the time you need to implement you need to change	Project_Management
Access to training	Training
People not willing to share information (peers)	Training
no information sharing sessions as a department	Training
Information shared in smaller groups. Not conveyed the same	Training
Development of employees	Training
Documentation control (there is confusion of templates applicable	Templates
We are using different processes (Matlosana and Platinum)	Templates
Lack of communication	stakeholders_management
stakeholders identification	stakeholders_management
stakeholders informing and communication	stakeholders_management
Engineers not available to sort out issues on site	stakeholders_management
Reactive to problems (not proactive)	Processes_and_procedure
Temporary solutions becoming permanent	Processes_and_procedure
processes are available but not follwed	Processes_and_procedure
processes are not known	Processes_and_procedure
Approval criteria not known	Processes_and_procedure
No procedure for change management is known	Processes_and_procedure
Pricing of projects different in different zones	Processes_and_procedure
Competence in technical work	Experience
Lack of knowledge	Experience
Learning curve	Experience
Projects moved from one person to the next	Documentation_information
Project hand over	Documentation_information
data not up to date	Documentation_information
Acceptance of projects from planning without sufficient information	Documentation_information
Input information from NED colleagues not accurate	Documentation_information
Input information from NED colleagues changed	Documentation_information
Generalised requirements (e.g. NWOU doesn't use indoor)	Documentation_information
management Decisions are always changing	Management
Planning for departmental projects	Management
No proper guidance (business related)	Management
Rely on one person	Management
New ideas crushed	Management

Overburdening one person (work not properly distributed)	Management
Job needed urgently	Management
Decision making (by the relevant technical approvers)	Management
Finance overrules technical solution	Management
time allocation for projects	Management
Design returned due to management processes	Management
Employees are always in the dark in relations to the rolling plan	Management
BPP should not stop training	Management
People taking on other responsibilities (electrification and sub-transmission)	multi_tasking
divided concentration	multi_tasking

Appendix A6: Interview with quality Expert

NED processes improvement sugestion validation	
Interviewer: A. B. Nzo	**Person interviewed:** Tebogo Mohapi
Designation: Engineer	**Designation:** Senior Engineer (Control Plant)

Purpose of interview: to validate the comments made by A.B. Nzo on how to improve the NED Processes Document in order to ensure that NED work is done correctly the first time.

Interview strategy:
Request interview with expert and explain the intention of the interview and the expected outcomes
Send the Current NED Processes Document, the comments for improvement, the findings from the factors affecting quality in NED and the interview evaluation form to the interviewee.
sit with the interviewee and discuss the suggestion.
Conclude with the interviewee on the suggestions made.

Suggestion	Comments
Get the document registered in the Eskom system?	Agree
Implementation plan for the document is not clear. Draft an implementation plan that will ensure that the users of the document are conversant with the document contents.	Agree
Table of contents needs to be updated it does not correspond with the document body	Agree
Introduction should be reworked to indicate the reason for having the document drafted. View proposed introduction.	Agree. The introduction as proposed can be implemented
Scope of the document field should be completed	Agree
Purpose of the document does not make any reference to Quality Management and assurance. Indicate that the document would address quality issues Proposed purpose: This document addresses the gaps identified by (A. Nzo 2015). It also serves as a guide to the NED employees on the processes and activities they need to perform in order to ensure quality in their work.	Agree.
The applicability paragraph needs to be re structured as follows: This document is only applicable to the NWOU's NED department (Major Engineering)	Agree
The author needs to acknowledge the references used in the document.	Agree
The document identifies the role players but does not indicate their responsibilities. Indicate the responsibilities of the role-players with reference to the document for e.g. The section managers as the monitors of the contents in this document have the responsibility to ensure that the contents in this document are carried out accurately	Agree

Process for monitoring: This field should address the processes that will be used to monitor the document. The method of monitoring the NED process should be included in the main body of the document.	Agree
The heading in paragraph 3 should not read **document content**: Rather say **NED quality management system**.	Agree
The objectives should be rewritten to portray the assurance of quality designs Proposed objectives: Adopt quality through all the levels of the department. Provide Engineering solutions that meet the customer's expectations. Ensure continuous improvement of the work and the personnel Meet the ISO 9001 requirements for quality management.	Agree with the proposed objectives however the original one was not incorrect either. Thus these can be integrated.
Instead of having this table in the document develop a tracking tool and make reference to that tracking tool in this document. This document will then be updated according to the developments of the actions on the tracking tool	Agreed. This will however result in more documents to monitor.
Essential documents: I had not commented	These seem to be too many documents to be essential documents. Identify those which have a direct impact on quality and make the others informative references
The following headings are proposed for the body of the document	
Commitment to quality Indicate the vision for the department Indicate how the management will demonstrate their commitment to quality. Indicate	Agree with the proposed paragraph in the commented document
NED work flow process Currently there are different processes indicated in the NED Processes document. It is recommended that the different processes (workflow from each section) should be integrated into one common work flow. Give a description of the activities in the processes and the deliverables from the process.	Do not completely agree. but I agree that the document needs to show how these processes are integrated and interlinked. Agreed with the suggestion to describe the activity in the processes.
Information management indicate a document management strategy for the department and how it should be applied and monitored (who, what when). Indicate how will it be ensured that the information used by the NED employees is accurate correct and the latest revision.	Don't agree. This will complicate things there is already, if not should be a separate document for documentation and information management. The NED Processes document may make reference to the document and the managers and supervisors should make sure that the personnel adhere to the documentation

	control systems specified
Customer relations Indicate in the document who is the customer, what type of customer the department is servicing and what the customers' expectations are. Indicate how the department will go about in ensuring that the services provided to the customer will satisfy the customer and how will the customer satisfaction be measured and monitored.	Agree
Training and competencies Indicate in the document the basic training modules that the employees need in order to conduct their work and use the tools available. Indicate how the performance of employees will be monitored and training interventions determined**.**	Agree
Method of implementation	
• The currently available systems have been analysed and validated. • Get management to support the development of a comprehensive QMS • Conduct thorough investigations on the contents of the QMS take suggestions made by A. Nzo and T. Mohapi into account • Identify means of monitoring the QMS • Complete QMS documents • Workshop all employees on the use of the QMS • Implement Monitor and improve QMS	Agree with the steps identified however feel that there is a bit more detail required each step on how will you ensure that the outcome is achieved on each step
Conclusion	The suggestions made are sufficient to resolve most of the departments quality issues however, for each field identified above a thorough investigation need to be done in order to fulfil the suggestions in each field. For example a thorough investigation needs to be done to determine how the different processes in different groups integrate and what impact it has on the work provided to the customer. In the study the issue of applicable templates is raised however no suggestion is made for this.