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RESEARCH REPORT:

An Analysis of Challenges in Implementing an Equipment Reliability Improvement Strategy:

Case Study Eskom Camden Power Station

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DECLARATION

I Keiso Lebohang Tsekoa declare that:

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(ii) I declare that the research reported in this dissertation is my original research. Where other people's work has been used (either from a printed source, internet or any other source), this has been properly acknowledged, except where otherwise indicated.

(iii) This dissertation has not been submitted for any degree or examination at any other university.

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ABSTRACT

In the late 2000s Eskom has been committed in maintaining and improving the levels of plant performance. Eskom main focus was on improving the production critical equipment reliability. Eskom Asset Management Department (AMD) established a strategy of optimising maintenance basis, namely Reliability Basis Optimisation (RBO). The RBO strategy provides for the right amount of maintenance and balanced preventative maintenance tasks to be carried out on the plant systems and equipment, in order to maintain and improve the plant's inherent reliability. The deployed RBO strategy is recognised worldwide and has been proven to be effective in improving plant performance in the electric utility sector. In the late 2000s Eskom implemented the strategy to all coal-fired power stations, as 85 percent of Eskom generating capacity is generated by coal-fired power stations.

In the past years Eskom Asset Management (AM) and Business Productivity Program (BPP) team, initiated a peer review on the progress of the RBO strategy implementation at the coal-fired power stations. The outcome of the review indicated that there are numerous shortcomings and challenges in the implementation of the strategy, at the coal fired power stations. The challenges related to Computerised Maintenance Management (CMM) system usage and Change Management (CM) philosophies. The main objective of this research study was to evaluate the key focus areas posing challenges in implementing the RBO strategy, in relation to CMMS usage and change management philosophies.

A case study was conducted in one of Eskom coal-fired power stations namely Camden power station. Camden power station a coal fired power station situated near the town of Ermelo in Mpumalanga. This power station comprises of eight units that each generates 200MW giving 1600MW to the national grid. The coal-fired power station was established in 1967 and mothballed in 1989 due to the unforeseen downturn in the South African economy and consequent negative electricity demand growth. In 2003 the power station was returned to service (RTS) due to the sharp increase in electricity demand. In the quest to obtain more generating capacity, Eskom considered additional megawatts from Camden first because of the low cost of refurbishment. Apart from design and construction to meet stricter environmental legal requirements, boiler and turbine plant had to be refurbished, and in some cases, equipment beyond repair had to be replaced. The upgrading of control and measurement systems required the redesign of plant, and in general, electrical switchgear, instrumentation, and cabling had to be replaced. The power station is currently giving 1481MW to the national grid with 3 x 200MW units, 2 x 195MW units, 1 x 190MW unit, 1 x 196MW unit and 1 x 185MW unit. The eight units were refurbished and synchronised onto the system.

The researcher used a descriptive and analytical cross sectional study approach. The analytical cross sectional study measures the outcomes and characteristics in a specific point in time and analysed quantitatively. The collection of empirical data from sources requires a defined target population. The population of this study was 75 employees, consisting of 51 engineering employees, 7 maintenance employees, and 17 works management employees.

The research instruments used in this study, for the purpose of collecting primary data, were semi-structured interviews and a survey questionnaire. The semi-structured interviews were conducted on a limited sample of five managers from engineering, maintenance and works management. The survey questionnaire was distributed to the entire target population which included managers. In this study purposive sampling was employed. The list of personnel of interest was obtained from the power station. The survey questionnaire was distributed to the entire target population through an online survey www.surveymonkey.com.

The interpreted results and findings of the research are that though the RBO strategy has been proven effective in power utilities, the human dynamics in the implementation of processes play a pivotal role. The successful implementation of a strategy or process is governed by proper change management implementation initiatives. From the study findings it is concluded that most of the study respondents, including the managers, negatively accept the RBO strategy; due to the grey areas in the implementation process.

They cited non-involvement in the implementation project planning as an obstacle. Timing for the RBO strategy implementation featured as a niche area. Respondents pointed out that time were inadequate for the implementers; in addition, managers did not fully understand the requirements of the RBO strategy; so, they were unable to support and allocate resources for the RBO strategy implementation. At some instances the RBO strategy is manned by untrained new employees. This research study has brought out many interesting issues that can benefit the organization tremendously on consideration for all new projects to be implemented successfully.

Supervisor: Prof JK Visser

Department: Graduate School of Technology Management

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LIST OF ABBREVIATIONS

AM	–	Asset Management
AMD	–	Asset Management Department
AMI	–	Asset Management Improvement
BPP	–	Business Productivity Programme
CBM	–	Condition Based Maintenance
CM	–	Change Management
CM	–	Corrective Maintenance
CMMS	–	Computerised Maintenance Management System
DMS	–	Document Management System
EPRI	–	Electric Power Research Institute
EUF	–	Energy Utilisation Factor
FMA	–	Failure Mode Analysis
FMECA	–	Failure Modes, Effects, and Criticality Analysis
GGCS	–	Generation Generic Component Strategies
GTD	–	Generation Technology Department
JIPM	–	Japan Institute of Plant Maintenance
MBO	–	Maintenance Basis Optimization
MM	–	Maintenance Manager
OEM	–	Original Equipment Manufacturer
O&M	–	Operations and Maintenance
PdM	–	Predictive Maintenance

PM	–	Preventive Maintenance
PMBD	–	Preventive Maintenance Basis Database
PSM	–	Power Station Manager
RBO	–	Reliability Basis Optimization
RCM	–	Reliability Centred Maintenance
RE	–	Reliability Engineer
RTF	–	Run-to-Failure
RTS	–	Return-to-Service
SE	–	System Engineer
SRCM	–	Streamlined Reliability Centred Maintenance
TPM	–	Total Productive Maintenance
UCF	–	Unit Capacity Factor

1. CHAPTER 1 - INTRODUCTION AND BACKGROUND

1.1. Background

Eskom is a state-owned electricity utility, and is among the top 15 global electricity utilities. Eskom supplies approximately 95% of South Africa's electricity need and more than 40% of the African continent making it the continent's largest electricity utility. The largest portion of the Eskom plant technology mix is coal-fired base load power stations. The majority of base load power stations have exceeded design half-life requiring well thought maintenance approaches managed efficiently. The required excess capacity for maintenance of the base load power stations is provided by utilising emergency resources (peaking power stations). Due to the growing demand of power supply, in South Africa and other African countries, the emergency resources have been depleted by constantly supplying power to the national power system in order to meet demand. During the period 2007 to 2016 this scenario left Eskom with little to no excess reserve capacity to sustain base load power stations maintenance operations, thus putting pressure on the electricity supply. In the process of striving to prevent the national power system from collapsing leading to national blackouts, Eskom's planned plant maintenance in some instances had to be deferred where possible. A typical coal-fired generating unit requires certain necessary routine and periodic maintenance, to ensure that it meets its technical performance requirements, is safe to operate and does not violate any environmental laws. The continual use of maintenance deferments as a lever in managing supply and demand side constraints is no longer a viable option and Eskom has no choice but to execute its maintenance program.

In the late 2000s Eskom committed to maintaining and improving the levels of plant performance. Therefore the main focus of Eskom was on improving the production critical equipment reliability. Eskom Asset Management Department (AMD) established an approach of optimising maintenance basis, namely Reliability Basis Optimisation (RBO). The RBO strategy provides for the right amount of maintenance and balanced preventive maintenance tasks to be carried out on the plant systems and equipment, in order to maintain and improve the plant's inherent reliability. On the completion and approval of this RBO strategy; the strategy was first rolled out to coal-fired power stations in 2009.

However the expected improvements in the plant performance, after the RBO strategy has been rolled out were not evident. Since 2008 the Asset Management (AM) and Business Productivity Programme (BPP) Team initiated a peer review on the progress of the RBO strategy implementation, the results indicated that the RBO strategy is not fully operationalized. The RBO strategy for its full operation requires efficient use of the Computerised Maintenance Management

System (CMMS). For most powers stations, it was noted that the CMMS was not sufficiently being utilised by end users.

The findings of the review concluded that the implementation of the strategy within Eskom Generation division, mainly at the coal-fired power stations, is facing challenges. According to EPRI (2010:3-1) any compromise in the maintenance basis process implementation is a compromise to the inherent reliability of the plant and can have detrimental safety, environmental and economic consequences. For Eskom to be able to obtain full benefits of the strategy, the implementation of the strategy has to be carefully executed. The fact that the foundation of reliability optimisation of the plant systems and equipment is maintenance basis, the importance of proper strategy implementation is paramount.

1.2. Research Problem

1.2.1. Problem Definition

Eskom has been faced with crucial decisions regarding the supply of electricity and maintaining the generation fleet. This has been attributed particularly by a sharp increase in the demand for electricity. In 2003 a strategic decision was taken to return to service (RTS) three of Eskom mothballed coal-fired power stations, namely Camden, Grootvlei and Komati. The RTS project for Camden power station, which is the power station of interest in this research study, was completed early June 2008 with all eight units re-commissioned.

Camden power station is 1600MW coal-fired power station established in 1967 which was mothballed in 1989 due to the unforeseen downturn in the South African economy and consequent negative electricity demand growth. In 2003 the power station was returned to service (RTS) and re-commissioned in 2008, due to the sharp increase in electricity demand. Camden is one of the power stations that have exceeded design half-life. According to the life of the station most of the equipment might be operating in the end of life zone. Some of the equipment might not necessarily be operating in the end of life zone as they might have been replaced or refurbished during the RTS. It would therefore require optimal maintenance practices for some equipment to improve the plant performance and maintenance of the inherent reliability.

In 2005 Eskom embarked on developing a standard maintenance approach to optimally maintain all plant equipment. Kudiwa (2013:11) indicate that Eskom invited a company from the United States of America (P&RO Solutions) to assist with improving the coal-fired power stations equipment reliability. The findings and recommendations of the pilot assessment on one of the power stations led to the development of a step-by-step approach; which mainly focused on planned maintenance optimization with the correct balanced mix of tasks to improve equipment reliability and resource utilisation. This strategy, named Reliability Basis Optimisation (RBO), has the basic principles of a streamlined Reliability Centred Maintenance (RCM) approach which was implemented at all coal fired power stations in 2009. Figure 1-1 illustrates the Reliability Basis Optimisation (RBO) model.

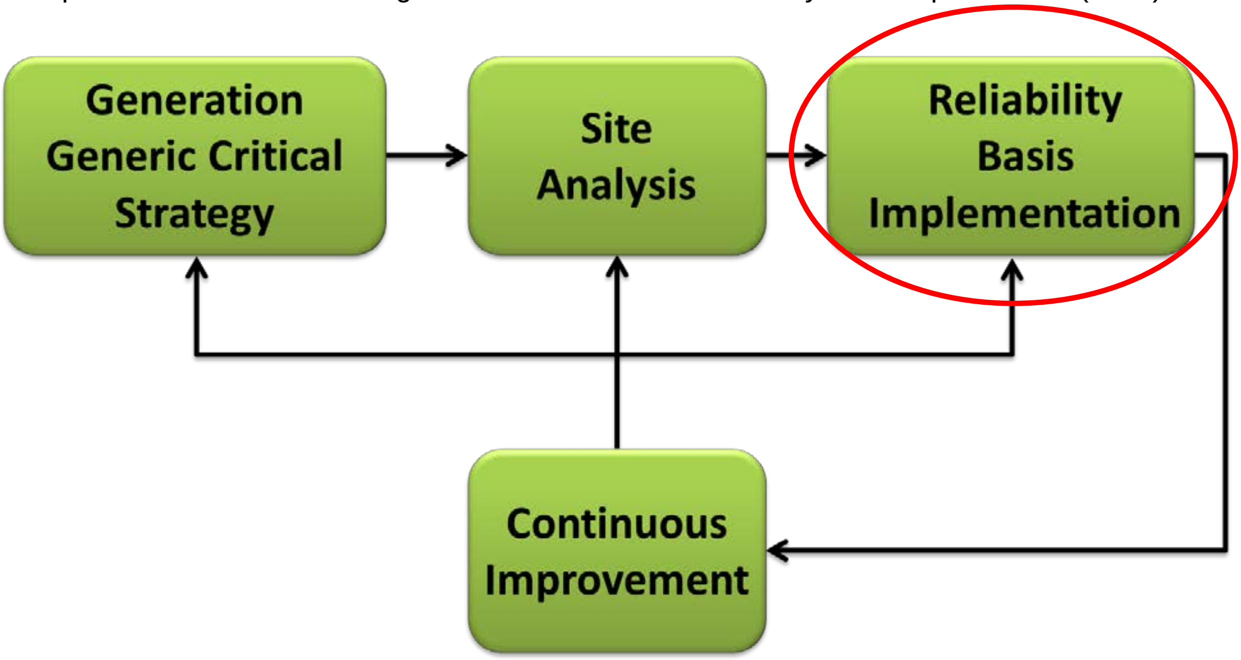

Figure 1-1: Reliability Basis Optimisation Model

Source: Eskom (2007)

Since 2010 Eskom Asset Management and BPP Team, initiated a peer review on the progress of the strategy implementation at the coal-fired power stations. The outcome of the review indicated that there are numerous shortcomings and challenges in the implementation of the RBO strategy, at the coal fired power stations. The challenges related to CMMS usage and Change Management philosophies. The current status of the RBO strategy implementation has led to the following problem statement: *The full operationalization of the RBO strategy has not been achieved in coal fired power stations to date.*

A high level investigation has uncovered the following findings:

- CMMS end-users are not utilising the system efficiently;
- The quality of information stored in the CMMS is not sufficient to perform job duties;
- Human dynamics consideration required for successful strategy implementation are lacking; and
- The required management support during the strategy implementation is not attained.

The section below states the research questions prompt by the investigation findings.

1.3. Research Questions

In order to uncover the impact that CMMS usage and Change Management philosophies have on the RBO strategy implementation in Eskom context, the following high level research questions were formulated:

- What features of the CMMS are used when executing maintenance strategies?
- What aspects are considered when measuring system information quality?
- What aspects of human dynamics are considered when implementing a strategy?
- What factors of management support are considered when implementing a strategy?

The research questions articulated the basis of this study main objective which is specified in the next section.

1.4. Research Objectives

The main objective of this research study was to identify the significant focus areas hindering the successful RBO strategy implementation, related to CMMS usage and change management philosophies, in a coal-fired power station.

In order to achieve the aforementioned objective, the following sub-objectives were addressed:

- To evaluate the CMMS utilization by end-users at the coal fired power station.
- To assess the level of quality of the information derived from the CMMS.
- To determine the extent in which human dynamics factors were considered in the RBO strategy implementation at the power station.
- To evaluate the level of support by management provided during the RBO strategy implementation at the power station.

The summary of the problem statement, research questions and research objectives is presented in Figure 1-2.

Problem Statement

The full operationalization of the RBO strategy has not been achieved in coal fired power stations to date.

Questions

- What features of the CMM system are used when executing maintenance strategies?
- What aspects are considered when measuring system information quality?
- What aspects of human dynamics are considered when implementing a strategy?
- What factors of management support are considered when implementing a strategy?

Objectives

- To evaluate the CMM system utilization by end-users at the coal fired power station.
- To assess the level of quality of the information derived from the CMM system.
- To determine the extent in which human dynamics factors were considered in the RBO strategy implementation at the power station.
- To evaluate the level of support by management provided during the RBO strategy implementation at the power station.

Figure 1-2: Research problem statement, questions and objectives

1.5. Variables Studied

The aforesaid research objectives led to the identification of the research measurement variables and sub-variables. The following variables and sub-variables were studied in this research:

1. *The use of CMMS in coal fired station*

    1.1. Access

    1.2. Functions

2. *Level of CMMS information quality*

    2.1. Complete

    2.2. Accessible

2.3. Relevant

2.4. Accurate

2.5. Timeliness

3. Consideration of Human Dynamics in strategy implementation

3.1. Communication Structure

3.2. Perceived Risk

3.3. Training

4. Management Contribution in strategy implementation

4.1. Management Focus

4.2. Management Support

1.6. Context of the research

Eskom is the South African electricity public utility producing approximately 95% of South Africa's electricity demand and more than 40% of the African continent demand. The largest portion of Eskom plant mix is coal-fired base load power stations. Eskom uses various technologies to generate electricity. Eskom's Generation Division manages 13 coal-fired power stations with an installed capacity of 37 715MW. These stations operate 24 hours a day to meet the demand for electricity. The figure below presents the primary energy mix of Eskom's power stations. It can be seen that coal power stations contribute 85% of Eskom's total generating capacity.

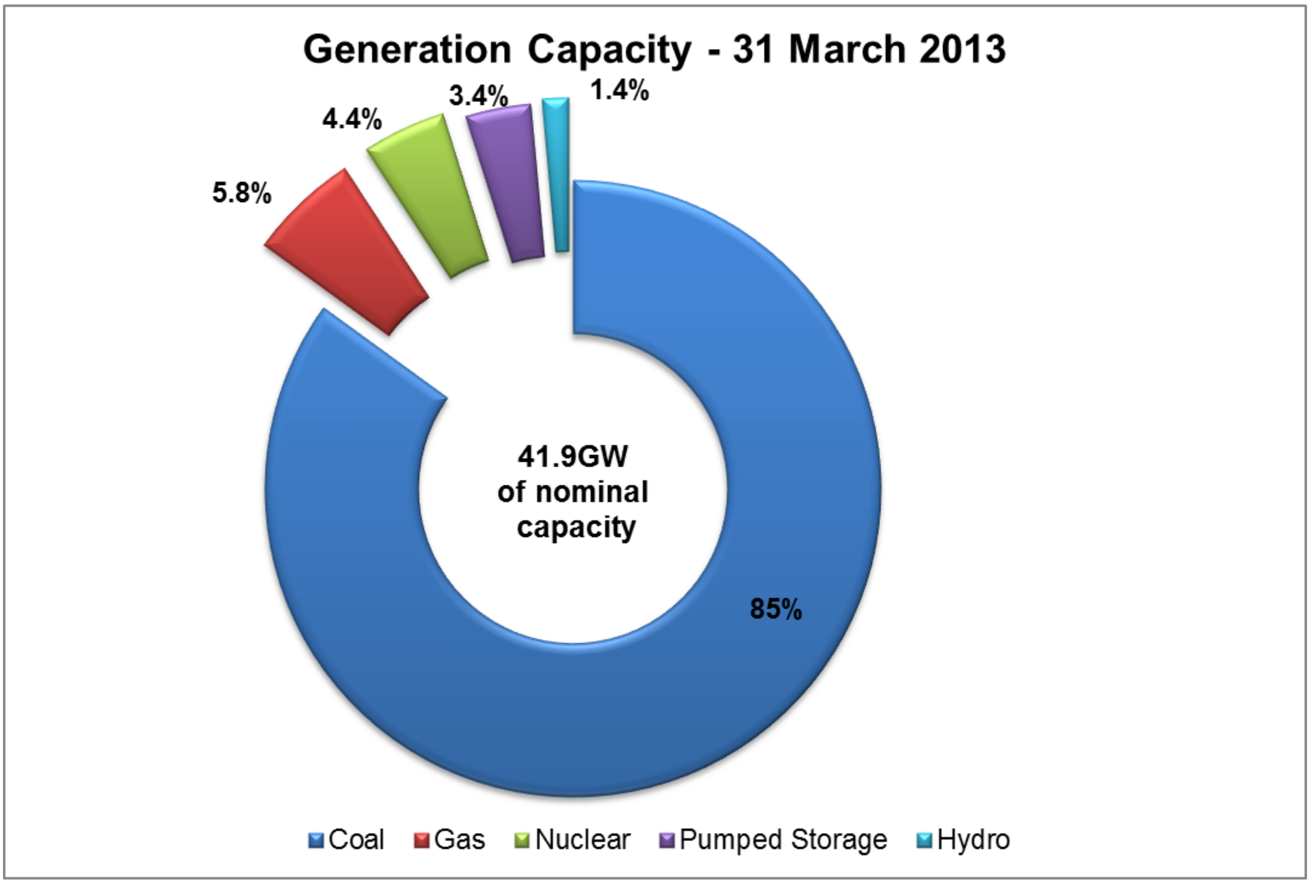

Figure 1-3: Net Maximum Generation Capacity in 2013

Source: Eskom Integrated Report 2013

Eskom is faced with a number of challenges. The most prominent challenge is that electricity demand is rising, while the available generating capacity remains limited and unreliable. Furthermore Eskom is under pressure to keep the lights on because it is the sole supplier to various sectors such as the municipalities, industrial, mining, commercial and international sectors. A more detailed breakdown of Eskom's supply statistics by sector is presented Figure 1-4.

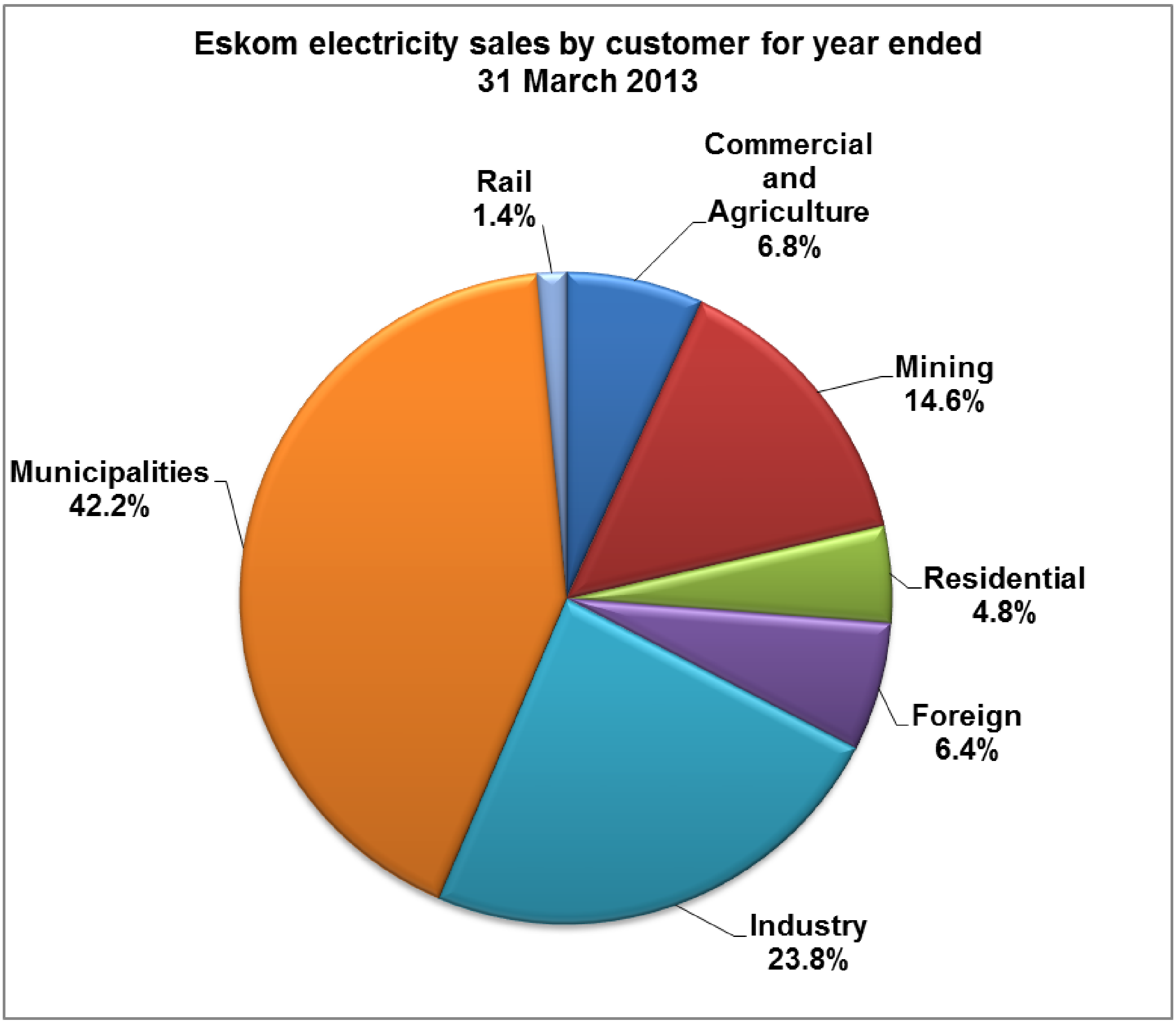

Figure 1-4: Electricity sales for 12 months ending 31 March 2013

Source: Eskom Integrated Report 2013

Maintenance remains a large concern for Eskom, this is led by tight operational reserves, financial constraints and high planned maintenance activities backlog. There are main aspects which affect the maintenance management approach within Eskom Generation. They are as follows:

1. Financial Constraints

2. Ageing Fleet

These aspects are discussed in detail below.

1.6.1. Financial Constraints

Eskom has three sources of funding namely revenue, equity and debt. Eskom uses its revenue to cover costs of the production and supply of electricity. Revenue alone is not sufficient to cover the cost of capital expenditure necessary for the growth and sustainability. Eskom funds its capital expenditure by making capital investment through debt (loan) and equity and recovering the investment over time through revenue. The amount of revenue Eskom can receive is determined by the tariffs that set the pricing structures of electricity. Eskom's electricity price is regulated by the National Energy Regulator of South Africa (NERSA) through the Multi-Year Price Determination (MYPD) over a period of three years. The latest application Eskom applied for was in April 2013 for a period of five years. Eskom applied for a 16% increase per annum for each of the five years. The 16% was structured in the following manner:

- 13% to cover Eskom own needs
- 3% for Independent Power Producers (IPP's) for renewable energy

NERSA only approved 8% annual price increase, which has left Eskom in a revenue shortfall over the period of five years (Eskom[1]: 2015).

NERSA approved 8% is structured as follows:

- 6% for Eskom's needs
- 2% for IPP's

NERSA's decision to reduce the requested increase leaves Eskom in a highly compromised position, as this impact on the ability to cover all costs and to secure additional funds. Eskom current inadequate generation capacity has meant that planned maintenance has been deferred in the past, creating a maintenance backlog and the deterioration of plant health and performance. This has led to a rising Unplanned Capability Loss Factor (UCLF) which places the security of supply at risk. However, performing planned maintenance creates a production shortfall, which needs to be in order to ensure balance in demand and supply. Because of the constraint system, Eskom has found it necessary to use Open Cycle Gas Turbine plants (OCGTs) to close the production shortfall. The usage of OCGTs for the required load is very expensive and has significant impact on Eskom financial sustainability. Due to financial constrains Eskom cannot afford to run OCTGs at current

[1]http://intranet.eskom.co.za/CommunicationsContentHub/Documents/NersaReasonsDecision.pdf (Downloaded 15th March 2015).

load factors unless additional funding is obtained. In addition, there is a further Capital Expenditure demand on Eskom because of the changes in the Power Station Emission Licence conditions. Compliance is critical to ensure that Eskom maintain its licence to operate. The current funding will only allow Eskom not to be able to achieve 100% of the compliance requirements.

1.6.2. Ageing Fleet

Eskom is faced with challenging aspects in driving to become a high performance organisation according to Eskom strategic objectives. Eskom has to ensure secure supply of electricity to consumers, with its existing infrastructure. The oldest of the base load generation fleet (coal fired power stations) has been built more than 40 years ago, thus giving rise to the issue of an ageing infrastructure. Furthermore some power stations have been operated in excess of their defined design life. The maintenance of these power stations requires a well thought maintenance approach that is efficiently managed. In addition three of Eskom oldest coal fired power stations namely Komati, Camden and Grootvlei were returned to service, in order to boost the security of supply (Eskom[2]: 2005). The information regarding Eskom base load generation fleet's age (as of 2013) is provided in the figure below.

2 http://intranet.eskom.co.za/CommunicationsContentHub/Documents/powerzone/LARGEDOCUMENTS/ANNUALREPORT2005.pdf (Downloaded 18th March 2015)

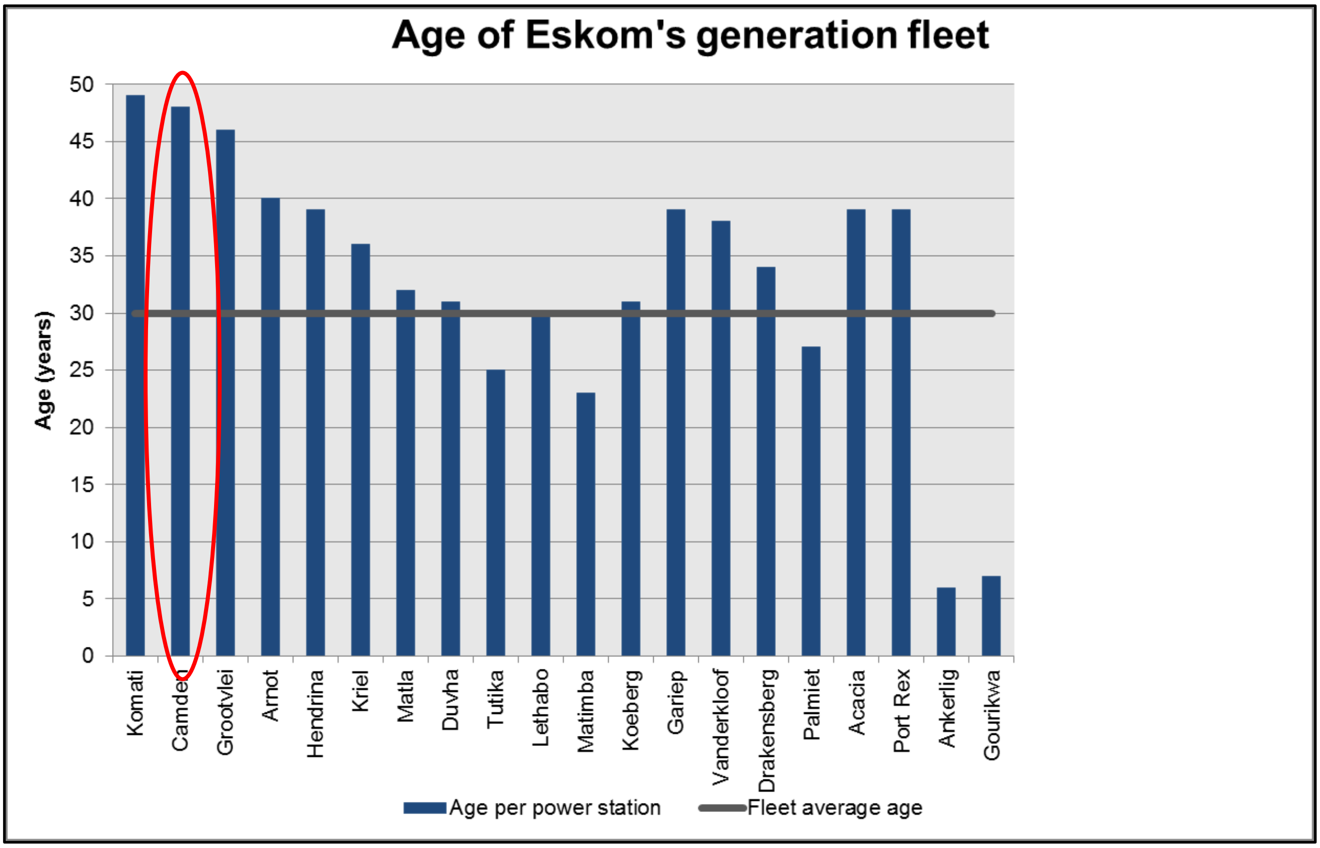

Figure 1-5: Age of Eskom's Generation Fleet

Source: www.eskom.co.za (2014)

It can be seen from the figure that the average age of the fleet is 30 years. Thirteen of the stations are already above the average with stations such as Komati, Camden and Grootvlei being the oldest.

Currently nine of the eleven coal fired stations have exceeded their design half-life and according to the bathtub curve (Figure 1-6) some equipment are operating wear out failures zone thereby increasing the failure rate of equipment. Furthermore, some equipment do not exhibit wear out failures but rather prone to random failures and not move on to the 'wear out' zone. The interpretation of the curve in respect of Eskom stations is that most of the stations now have equipment that is operating in the wear out failures zone. Not all the equipment may be operating in this zone, as some equipment is still new from the time when the old ones were refurbished or replaced.

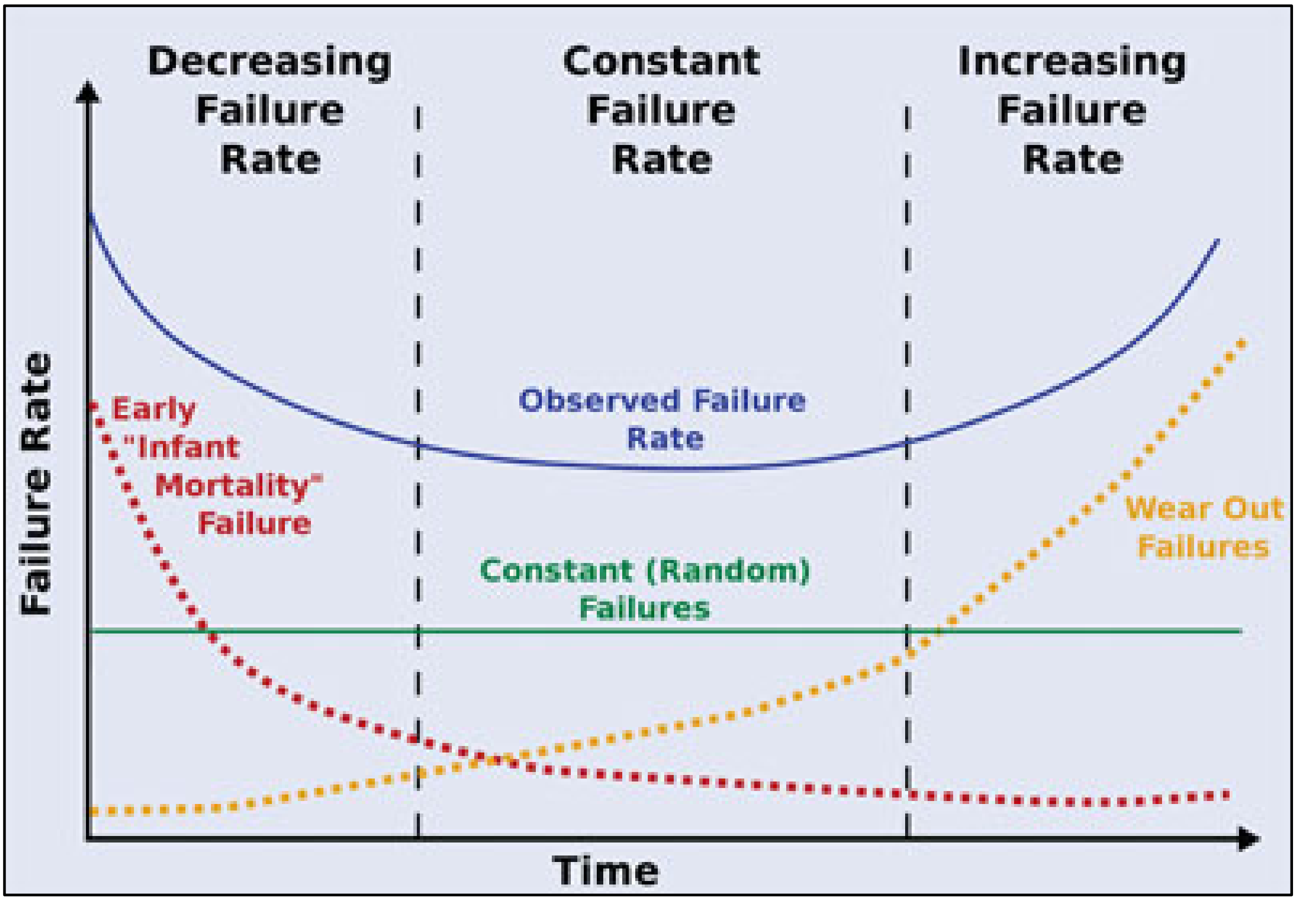

Figure 1-6: Bathtub Curve (equipment-failure rate vs. time)

Source: www.maintenancetechnology.com (2015)

Given the current situation in which Eskom finds itself, the way forward for maintenance functions is to improve the reliability of the production critical equipment; in so doing optimising maintenance practices. This requires change in the maintenance approaches and introduction of new technologies to reach Eskom business objectives.

1.6.3. Power Station Case Study

Camden power station is a coal fired power station situated near the town of Ermelo in Mpumalanga. This power station comprises eight units that each generates 200MW giving 1600MW to the national grid. The coal-fired power station was established in 1967 and mothballed in 1989 due to the unforeseen downturn in the South African economy and consequent negative electricity demand growth. The first unit was commissioned in 1966 and it is now 49 years old. In 2003 the power station was returned to service (RTS) due to the sharp increase in electricity demand. In the quest to obtain more generating capacity, Eskom considered additional megawatts from Camden first because of the low cost of refurbishment. Apart from design and construction to meet stricter environmental legal requirements, boiler and turbine plant had to be refurbished, and in some cases, equipment beyond repair had to be replaced. The upgrading of control and measurement systems required the redesign of plant, and in general, electrical switchgear, instrumentation, and cabling had to be replaced. The power station is currently giving 1481MW to the national grid with 3 x 200MW units, 2 x 195MW units, 1 x 190MW unit, 1 x 196MW unit and 1 x 185MW unit. The eight units were refurbished and synchronised onto the system.

1.7. Rationale of the research

Kudiwa (2013) concludes that Eskom environment is not conducive for the implementation of RBO strategy due to a number of challenges, in turn making it difficult for Eskom to realise the potential benefits.

- The findings of this study will assist power stations in improving the deployment of the RBO strategy in power stations; thereby increase the prospects of improving plant's performance and inherent reliability.

- Decision makers will be able to understand the most contributing factors hindering the success of RBO strategy implementation in power stations, and subsequently take the required corrective action.

Though the focus of this study was on one power station, the findings could be applicable to other power stations within Eskom's Generation Division.

1.8. Limitations and assumptions of the study

The descriptions that determined the fundamentals that were within the scope of the research are as stipulated below:

- The research study was not an in depth technical investigation.

- The research study was not to compare maintenance strategies. It focused on the implementation process of the RBO strategy to establish the key challenges that are aligned to the research questions.

- The scope of the research was limited to the Power generation sector and more specifically coal fired power station, Camden Power Station, which was of interest for this particular research.

The limitations of the research were as follows:

  - The research was limited by the Masters Study program time frame for the completion.

- The research methods were limited to those that enabled the researcher to gather reliable and rigorous data.

The key assumptions for this research were the following:

- The maintenance optimisation has demonstrated an effective realization of improved equipment availability, maintainability and reliability.
- Maintenance optimisation has also helped the organisations in improving the interaction between the maintenance department and other functions. The interaction results in reduction of unplanned maintenance incidents, improved production reliability and availability and reducing O&M cost. Thereby strengthening sustainability efforts of the organization to meet cut-throat global competition for business excellence.
- An effective planned and scheduled PM program ultimately pay off in terms of productivity gains, less system/plant downtime and better utilization of personnel resources.

1.9. Research Study Method

The research method consisted of a comprehensive literature review with substantiated field research, semi-structured interviews and survey questionnaire of a power generation case study.

The comprehensive research strategy consisted of: (see Figure 1-7)

- A literature review that identifies the key challenges influencing the implementation of a strategy within an organisation. The Electric Power Research Institute (EPRI) has done a lot of studies and researches in the power generation, transmission and distribution business, and these were used for comparison with world class practices.
- The Document Management (DM) System was used to obtain PM and Schedule compliance reports of the power station at the power station.
- Limited semi-structured interviews conducted with power station managers: engineering, maintenance and work management.
- An on-line survey questionnaire was created on www.surveymonkey.com.
- The survey questionnaire was distributed to a pre-selected small sample for pre-testing and validation.

- Structured questionnaire was then distributed to engineering, maintenance and work management departments.

- Analysing the results of the data to determine the conclusions and recommendations in identifying the key focus areas that contributed to RBO strategy implementation challenges.

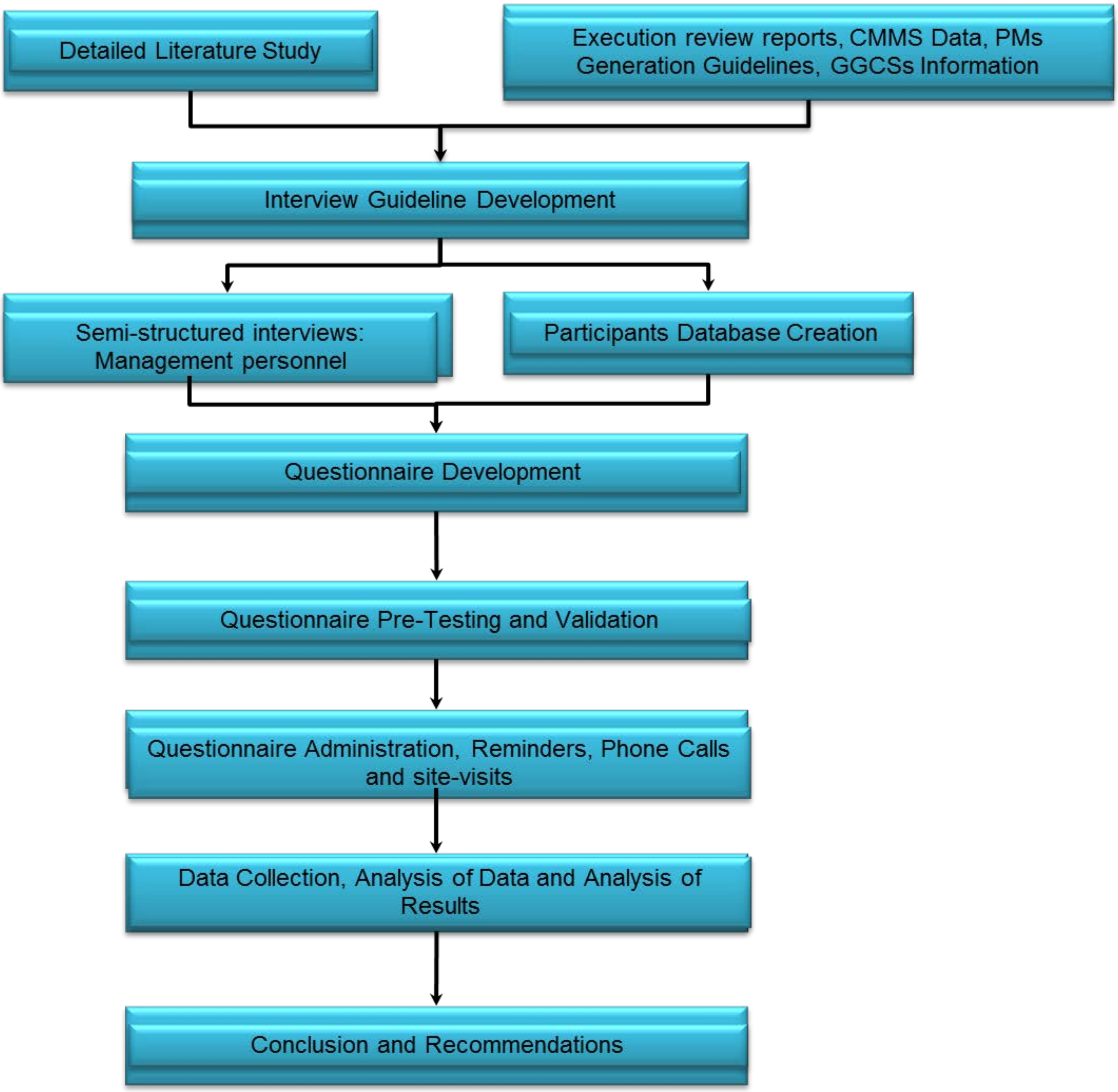

Figure 1-7: Research Method

1.10. Summary

An overview of the topic and context of the study is given, indicating the need of optimal maintenance practices within the Eskom generation fleet. Furthermore the research context reveals a picture of the pressure experienced by the Eskom. The increased electricity demand further exerts additional pressure to the current operational challenges. The research design and method are indicated briefly. The next chapter will discuss available literature on related to the research problem, objectives and goals.

2. CHAPTER 2 – LITERATURE REVIEW

2.1. Introduction

In order for Eskom to ensure high reliability and availability of its generating assets, the maintenance functions have to improve the reliability of the production critical equipment. This can be achieved by optimising maintenance practices. Maintenance optimisation requires maintenance practices review, streamlining, transformation of the maintenance approaches and introduction of new technologies to reach the objectives. In the late 2000s the primary focus for Eskom's generation business has been the attempt to improve equipment reliability. The focus concluded in the development of a strategy named Reliability Basis Optimisation (RBO).

The philosophies of the RBO strategy are based on EPRI Plant Maintenance Optimization (PMO) Guidelines. PMO is an overall process to improve an organisation maintenance business in order to improve equipment reliability. Al-Mishari & Suliman (2008:61) present PMO as an alternative to RCM, which was developed to reduce cost and time required to conduct a full RCM analysis. In addition, PMO is described to analyse the existing maintenance tasks in terms of their need and optimal execution of the maintenance tasks.

EPRI (2003:2-2) explains that PMO is governed by the principles of Maintenance Basis Optimization (MBO) process. MBO is a step-by-step approach to optimize the Maintenance Basis by incorporating plant knowledge, maintenance history, and industry experience. Traditionally, the RCM approach, in the power utility sector, has always been recognized as an effective approach for determining the optimal amount of preventive, predictive and corrective maintenance to be performed on systems and equipment component parts. EPRI (2003:2-2) elucidates the well-known RCM as one form of MBO. The RCM process is considered a labour intensive initiative when applied on a fleet wide basis. In addition, EPRI (2010:1-4) states that the formation of the MBO process originated from the power generation utility, in the quest for a less rigorous maintenance approach than that of the RCM process.

The purpose of this chapter is to ascertain the theory relevant to research questions and objectives. The chapter covers and elaborates on the relevance of the research issues, questions and also examines contemporary theories on equipment reliability, maintenance optimisation, CMMS application and Change Management philosophies around strategy implementation in coal-fired power station environment. The section that follows covers equipment reliability for better understanding of it's the relevance in the power generation utility.

2.2. Equipment Reliability

Duran (Schuman & Brent (2005:570)) defines operational reliability as "*a flexible process that optimises people, processes and technology, and thereby enabling companies to become more profitable by maximising availability and value addition of producing assets."* In addition the four key elements that make operational reliability are classified in the figure below. Additionally, Melo & Pereira (1995:1014) state that by improving equipment reliability the system performance is enhanced. This is achieved by employing additional maintenance personnel to reduce downtime or adopting more sophisticated monitoring and maintenance techniques to extend uptime.

In the steel manufacturing industry, Liptrot & Palarchio (2000:919) states that through experience the best way to improve equipment reliability is a strategic and comprehensive approach to physical asset management. Similarly, Liptrot et al. (2000:922) identify the key to equipment reliability as identification of the proper work done at the right time. Whereas, Al-Mishari et al. (2008:69) advocate the use of Six-Sigma in addressing many RCM flaws and weakness when integrated with other reliability techniques. Furthermore, the integration of six-sigma can produce results more objective and dependable.

In addition Schuman et al. (2005:570) base operational reliability on four key elements or focus areas, namely human reliability, equipment reliability, equipment maintainability and process reliability that should be addressed jointly to ensure long-term continuous improvement towards optimisation. Figure 2-1 summarises the focus areas.

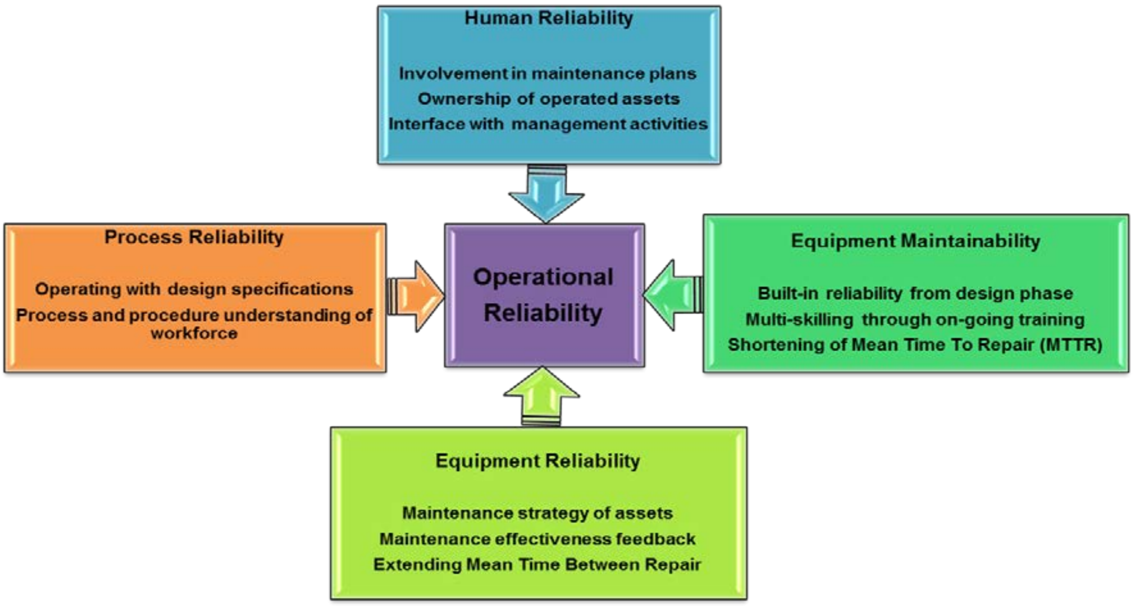

Figure 2-1: The four essential elements of operational reliability

Source: Schuman et al. (2005:571)

The figure indicates that to improve equipment reliability the underlying principle is maintenance basis. EPRI (2003:2-2) defines maintenance basis as "*a documented rationale for understanding expected equipment and system failures as well as their associated maintenance tasks and frequencies; to achieve an organization's desired goals for safety, equipment reliability, and O&M costs* ".

Furthermore, Endrenyi et al. (2001:638) explain the effect of maintenance on the component or system reliability in this manner "*if too little maintenance is done, this may result in an excessive number of costly failures and poor system performance and, therefore, reliability is degraded; if maintenance is done too often, reliability may improve but the cost of maintenance will sharply increase*." This indicates the requirement of optimal maintenance and the correct balanced mix of tasks.

However, in the literature it is noticeable that the term Reliability-Based Optimization (RBO) is used in the design phase context for optimising the equipment reliability. Valdebenito & Schuëller (2010:645) define RBO as "*a methodology that allows solving optimization problems while explicitly modelling the effects of uncertainty; these effects are accounted for by means of probabilities of occurrence and expected values*". Youn, Choi & Park (2003:221) explain the utilisation of reliability-based approaches at design optimization due to the existence of uncertainties in physical quantities such as manufacturing tolerances, material properties, and loads.

It is deduced that the term RBO in improving reliability is correct in the design phase. For this research study the main objective of the strategy in question is: The improvement of equipment reliability. The main focus of the strategy is optimising the correct maintenance practices. In the next section literature on maintenance is discussed. Maintenance definitions; maintenance techniques; and maintenance optimisation models are presented.

2.3. Maintenance

"Maintenance and outage work is estimated, scheduled and controlled at a much greater level of detail than normally required on a typical engineering and construction project."

Chapman 1993

Literature indicates that the strategic importance of maintenance has not been given much attention by organisations in the past. Tsang (2002:7) explains that organisations regarded maintenance as an expense that belongs to operating budget. Furthermore, Lazakis, Turan & Aksu (2010:338) explicate that maintenance was initially reflected as' necessary rework' with not much attention given. However, the importance of maintenance management and maintenance function has been growing throughout the years. Moreover, Dekker (1996:229) states that in companies the number of maintenance personnel and portion of maintenance costs, in the total operation costs, has increased. In addition, Garg and Deshmukh (2006:205) further state that the largest departments in refineries are maintenance and operation which each comprises about 30 percent of the total manpower. This subsection of the literature review therefore aims to focus on the general view of maintenance within the power generation context. This is attained by closely studying relevant literature and picking out the various settings in which the word maintenance is used. For a common understanding, before the applicable literature is reviewed, a general definition of maintenance is given.

2.3.1. Universal Maintenance Definitions

Weinstein, Vokurka & Graman (2009:499) cite the definition of maintenance as '*the activities intended to preserve or promptly restore the safety, performance, reliability, and availability of plant structures, Systems and components to ensure superior performance of their intended function when required'*. British Standards (BS 1993) as quoted by Lazakis et al. (2010:338) states the definition of maintenance as: *'The combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it, to a state in which it can perform a required action'.* UK Department of Trade and Industry (DTI) (in Labib (2008:417)) definition of maintenance is: *'The management, control, execution and quality of those activities which will ensure that optimum level of availability and overall performance of plant are achieved, in order to meet business objectives'*.

Maintenance is generally defined as activities or actions taken to preserve or retain or restore an item to perform the intended function, in order to meet business objectives. These activities are different in nature, and require different techniques to carry out. Maintenance techniques are discussed in the next sub-section.

2.3.2. Type of Maintenance Techniques

Maintenance practices have evolved in the past years from corrective maintenance, to preventive maintenance and on to predictive maintenance. Batun & Azizoğlu (2009:1753) define two types of maintenance activities namely corrective and preventive maintenance activities, as '*corrective maintenance is carried out after a breakdown to bring the machine into its operating state, whereas preventive maintenance is planned and performed to keep the machine in its operating state'.*

British Standards (BS 1993) quoted by Lazakis et al. (2010:339) defined corrective maintenance as '*the maintenance carried out after fault recognition and intended to put an item into a state in which it can perform a required function*'. Weinstein et al. (2009:499) define preventive maintenance as a proactive approach to reduce repair and lower maintenance costs by planned regular maintenance work.

Dhillon, as quoted by Sharma, Yadava & Deshmukh (2011:6) stated three types of maintenance categories as:

1) ***Preventive maintenance*** – all actions carried out on a planned, periodic and specific schedule to keep an item/equipment in stated working condition through the process of checking and reconditioning.

2) ***Corrective maintenance*** – unscheduled maintenance or repair to return items/equipment to a defined state, carried out because maintenance persons or users perceived deficiencies or failures.

3) ***Predictive maintenance*** – the use of modern measurement and signal processing methods to accurately predict and diagnose items/equipment condition during operation.

The roadmap regarding maintenance practices evolution is provided in the figure below.

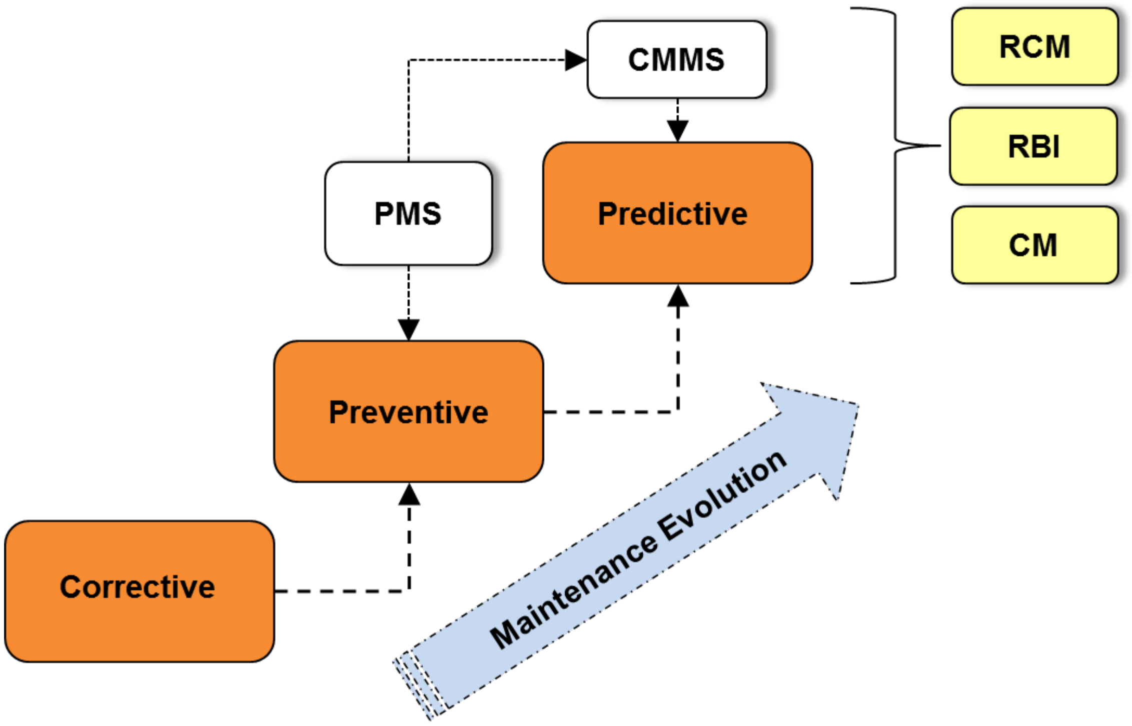

Figure 2-2: Evolution of Maintenance Techniques

Source: Lazakis *et al.* (2010)

The aim of the maintenance function is to contribute towards an organization's profit, clearly bringing the need for maintenance operations to be in harmony with the corporate objective (Sharma et al.

(2011:5)). In support, Andrawus, Watson & Kishk (2007:101) explain that maintenance optimisation for industries utilising physical assets is of crucial issue, given the impact of maintenance on cost, risks and plant performance. Maintenance practices have evolved with time, aiming optimise maintenance strategy that can result to improved plant performance contributing to the organisation profit margins.

2.3.3. Maintenance Optimisation Models

Maintenance optimisation has been researched since the early 1960's by researchers like Barlow, Proschan, Jorgenson, McCall, Radner and Hunter (in Dekker (1996:229)). Dekker (1996:231) defines maintenance optimization models as "*those mathematical models whose aim it is to find the optimum balance between the costs and benefits of maintenance, while taking all kinds of constraints into account*". Furthermore, explains the four aspects covered, in general, by maintenance optimisation models as:

1) a description of a technical system, its function and its importance;

2) a modelling of the deterioration of the system in time and possible consequences for the system;

3) a description of the available information about the system and the actions open to management; and

4) An objective function and an optimization technique which helps in finding the best balance.

Tam & Price (2007:364) explain maintenance optimisation, for asset managers, as a complex and detailed problem encountered in daily operation. Though, Andrawus et al. (2007:101) describe the quantitative maintenance optimisation model as Modelling System Failure MSF (using Monte-Carlo simulation). This model investigates equipment failure patterns by using failure distribution, resource availability and spare-holdings, in order to determine optimum maintenance requirements. The Delay-Time Maintenance Model (DTMM) examines equipment failure patterns by considering failure consequences, inspection costs and the period to determine optimum inspection intervals.

Hilber (2008:7) defines maintenance optimisation as a methodology aimed at finding optimal balance between preventive and corrective maintenance with respect to the organisation objectives, reliability, appearance and worth of the maintained equipment and use of existing labour. In literature RCM is classified as the qualitative maintenance optimisation model. Sharma et al. (2011:10) mention that maintenance optimization models can either be qualitative, quantitative or both.

Vant, Hokstad and Bodsberg (1996:241) explain the objective of RCM methodology as identifying the optimal maintenance for each component, taking into account the safety requirements, maintenance costs and lost production costs. The methodology in question in this research study has been classified on the principles of Streamlined Reliability Centred Maintenance (SRCM). Therefore, it is realized that the model of interest is a qualitative maintenance optimisation model. In the attempt to improve equipment reliability by optimising maintenance practises, it is essential to use computers to deal with the tremendous management information and complexity related with maintenance. Werner & Vetter (2005:781) state that electric utilities are increasing the use of Information Technology (IT) application in maintenance management, in order to support business processes. The next section will illuminate more on the application of Computerised Maintenance Management System (CMMS) in the power generation environment.

2.4. Computerised Maintenance Management System (CMMS) in power generation

"Successful CMMS is expected to help electric utilities manage resources effectively and improve utilities' efficiency considerably"

Huo & Zhang (2003)

The use of SAP PM in Eskom Generation group, as a Computerised Maintenance Management System (CMMS), is limited to maintenance routine work management. The use of CMMS in Eskom context is a computerised maintenance work execution system assisting in raw data collection, historical records storing and maintenance reports generation.

Werner & Vetter (2005:781) explain the elements of CMMS, in the power utilities context as: work orders and reports, and allows dispatching of maintenance crew. Through the reviewing of related literature across industries that had some form of maintenance data management, it was found that the common terms used for this system is CMMS. The definitions of CMMS are provided below.

2.4.1. Definitions of Computerised Maintenance Management System

Fernandez, Labib, Walmsley & Petty (2003:966) define computerised maintenance management Systems (CMMSs) as *"computer based software programs used to control work activities and resources used, as well as to monitor and report work execution. CMMSs are tools for data capture and data analysis."* Additionally, Ruud (2009:36) further define CMMS as "*software that contains information about company's maintenance operations".* The use of CMMS is explained as a helpful tool for maintenance workers to work more efficiently.

For the purpose of this research study any computer based software programme satisfying the below mentioned criterion is classified as a CMMS:

- A computer based software program
- Automates maintenance work activities and resource used
- Monitors and records work execution
- Collects and stores historical maintenance data of the plant and can therefore be referred to as a historian (generates reports)
- Retrieve stored data, to provide information of plant maintenance history. This includes all parameter measurements specified for inspections.
- None real-time data can be obtained from the System

The use of CMMSs in maintenance functions has made maintenance management easier. The system assists maintenance managers in better planning, efficient control of the maintenance costs and decision making. Evans, as quoted by Carnero & Novés (2006:336) indicates that 70% of maintenance software implementation fails, due to lack of suitable projects for set-up and control. The CMMS functionalities must be aligned to maintenance and operation objectives in the selection of the system, in order to realise return on investment. The primary functions of CMMS are covered in the next section.

2.4.2. Characteristics of CMMS

O'Donoghue & Prendergast (2004:228) state the objectives of the Computerised Maintenance Management System (CMMS), in the textile manufacturing company, as; to improve maintenance costs, reduce equipment downtime as a result of scheduled preventative maintenance, and increase the equipment life, the ability to store historical records to assist in the planning and budgeting of maintenance, as well as the ability to generate maintenance reports. Additionally, in the review study of maintenance management literature, Garg & Deshmukh (2006:217) state the capabilities that CMMS provides as: to store, retrieve and analyse information. In the research study of supporting maintenance management System development and implementation, Fernandez et al. (2003:965) further describe CMMS as a powerful tool necessary for obtaining information from raw data and support the decision-making process. Mohedano et al., (in Carnero & Novés (2007:336)), outline modules of a typical CMMS as:

- ***Work orders***: This module leads to planning, co-ordination, control and follow-up of maintenance activities, carried out using its own methods as well as others.

- ***Equipment/buildings**:* It incorporates the definition and management of information relating to the facilities and existing equipment in the company, qualifying them according to technical and functional criteria, defining their technical characteristics, supplies, location, economic information, etc.

- ***Store**:* In this module the elements are controlled in stock and a follow-up of refills is carried out (stored, not stored and special); it indicates when the stock is below the minimum level for every element in their different stores and creates buy requests for its reinstatement.

- ***Materials and services**:* This module provides the tool for the preparation and generation of purchased orders and the receipt of materials as well as services.

- ***Resources*:** It provides information about resources and suppliers, maintenance companies, service contracts and services as well as the record of information associated with the machinery and tools which may be used in the different work orders.

- ***Personnel:*** It stores information about the company's own personnel as well as sub-contracted and specialised workers (Raouf et al.. 1993).

- ***Reports and warning***: It provides a wide variety of standard basic reports and indicators such as the identification of the reason of the breakdown, the plan of corrective work, the number of times that it has happened, etc.

- ***Maintenance policies**:* It integrates the maintenance activities that are established in the company as corrective, preventive and predictive maintenance.

The basic functions of a CMMS are presented in the figure below.

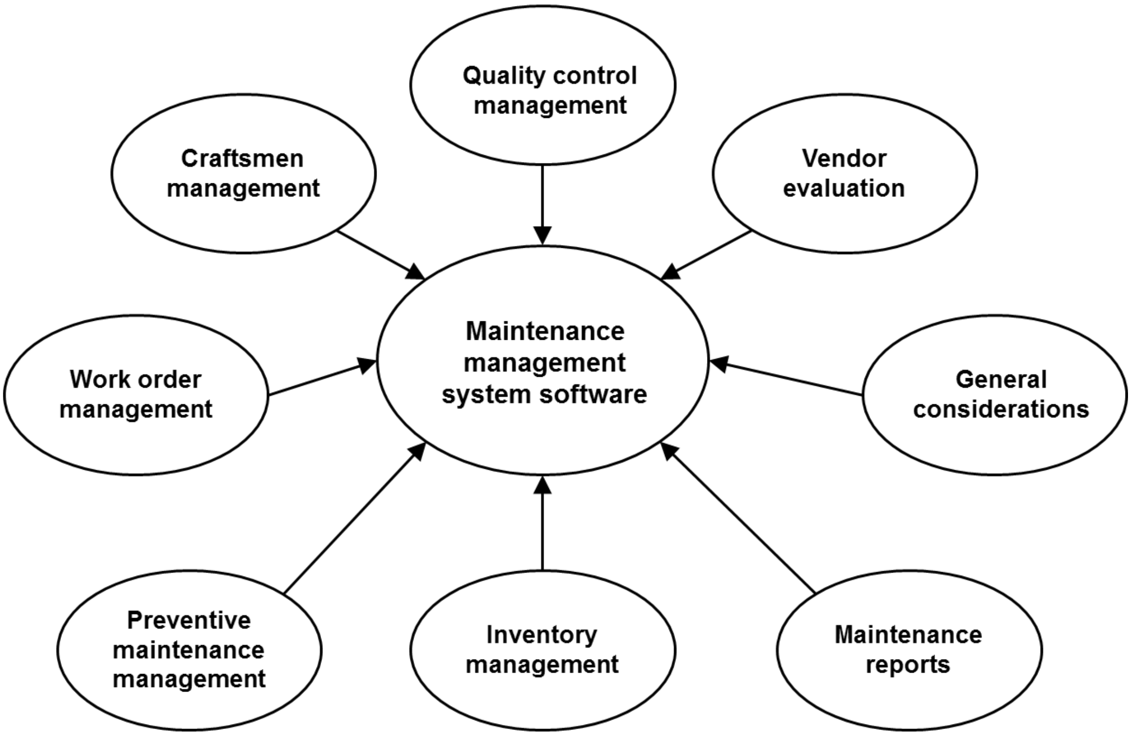

Figure 2-3: Basic Functions of a CMMS

Source: Raouf et al. (1992)

An increasing organisational awareness of this system has made it difficult for the maintenance function to ignore. The CMMS is known for its advantages such as managing the maintenance operations on capital equipment, other assets and properties. It also helps maintenance personnel and departmental managers to make better decisions regarding allocation, maintenance, scheduling and disposal of capital equipment, assets and properties. Huo et al. (2003:4608) explain that CMMS assists in increasing the organisational information processing capacity to support the ability to make quick and accurate decisions.

The common uses of CMMS in the power generation, by maintenance function, are presented in the next section.

2.4.3. CMMS Functions in power generation

Huo, Zhang, Wang & Yan (2005:3) list the fundamental functions of CMMS in electric utilities as follows:

Work Orders Management: CMMS allows the utilities to electronically track work orders within a centralized software package. CMMS can generate work orders automatically, in which such information can be included as maintenance workers, materials (inventory items) and tools etc. The work order history information is stored in the database. The information can be viewed; report or graph equipment downtimes; report causes of failure, resources allocated and track maintenance costs.

Preventive Maintenance Management: CMMS can help to implement preventive maintenance tasks. Preventive maintenance is essentially a list of work orders that have to be performed at a certain time interval or based on some meter reading. Weekly, monthly, quarterly, semi-annual or annual tasks generated for proper equipment maintenance. CMMS prompts when the equipment is ready for routine maintenance.

Stores Management: CMMS packages can also assist in the users in tracking materials in storerooms. This is often referred to as "inventory". It can be a complex task keeping track of items in an inventory and thus the software assists greatly in this manner. Also, this allows the work order administrators to choose from a list of materials in the system which items will be needed to do the work.

Assets Management: Usually CMMS packages allow the users to track and enter all of the equipment (sometimes called assets) at the facility. This makes it easier to select what needs to be worked on when a work order is created. This information about equipment is also included, such as: visual information, manufacturing information, installation information, operation information and maintenance information etc.

Labour Management: Most maintenance and engineering managers have been faced with the requirement of having to justify staffing levels or increased manpower. The availability of quantitative data would greatly simplify this justification process. By using CMMS to document labour hours, over time managers can build a significant amount of useful information. Thus, the CMMS plays an important role in budgeting times because different crafts usage can be easily stored and retrieved, and a detailed account of crafts usage can be obtained.

Report Management: CMMS can generate reports and graphs from a variety of fields ranging from equipment, cost centres, projects, labour, inventory, reason for outage, parts usage, and so forth.

The summary of the fundamental functions of CMMS in electric utilities maintenance functions is presented in the figure below.

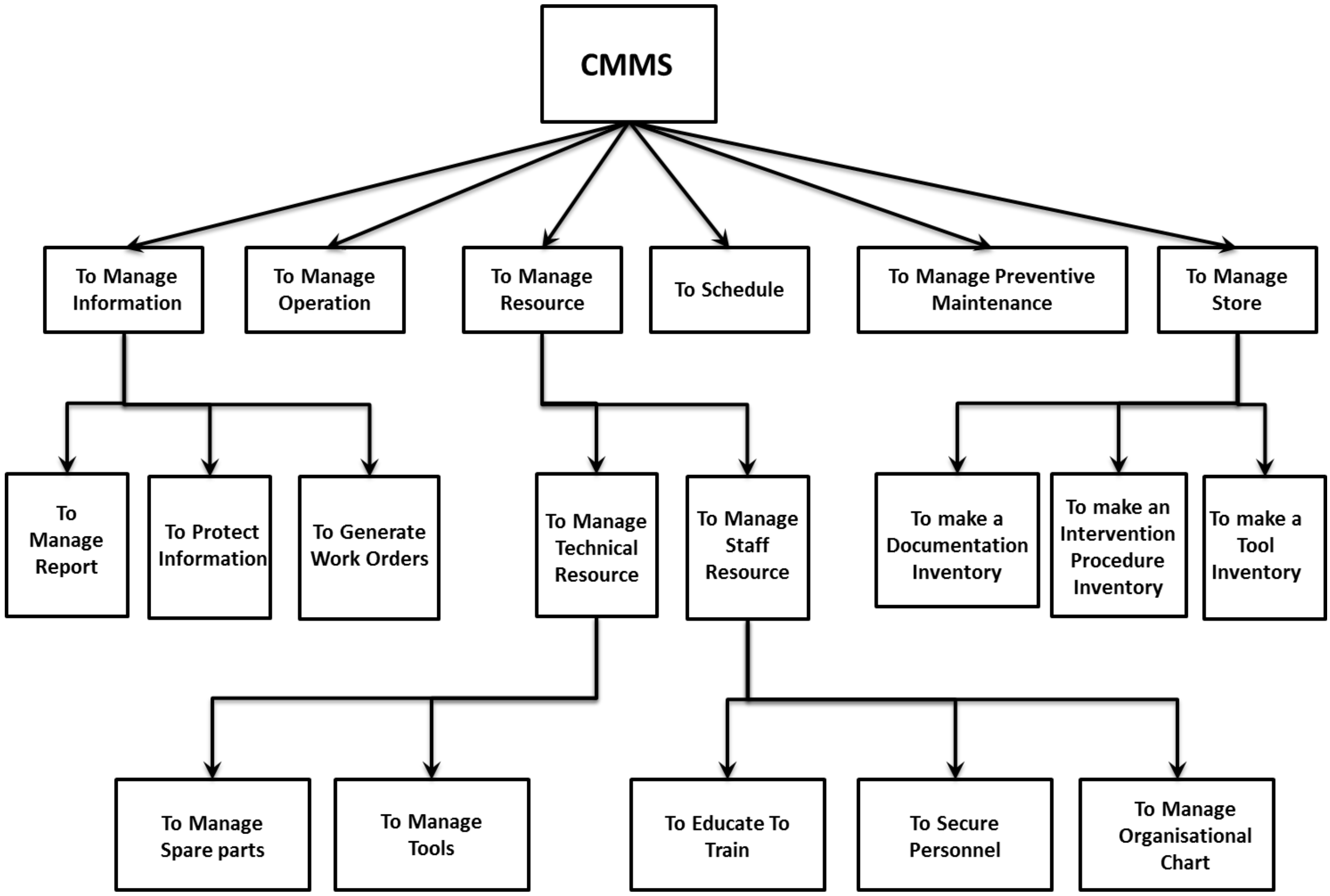

Figure 2-4: Fundamental Functions of CMMS

Source: Huo et al. (2005)

Huo et al. (2005:6) conclude that RCM analysis is highly dependent on the accuracy and completeness of the information captured on CMMS.

It can be deduced that the success of the strategy being implemented is highly dependent on the completeness and accuracy of the information derived from the CMMS. In the following section, literature relating to information quality is covered.

2.5. Information Quality

Information quality is one of the critical problems facing organizations today. As management becomes more dependent on information Systems to fulfil their missions, information quality becomes a larger issue in their organizations.

Fisher & Kingma (2001)

Eskom strives to provide prompt cost beneficial quality information, in order to provide sustainable electricity solutions to grow the economy and improve the quality of life. Strategic decision making is often based on available information. Fisher et al. (2001:110) state that decision making with poor quality information has immense impact. Choices are made based on limited resources and poor decisions made by misinformed people. Michnik & Lo (2009:851) regard information quality in communication process as a background for all steps. Furthermore, Lee, Strong, Kahn & Wang (2002:133) indicate the increasing need for, and awareness of, high quality information in organisations due to the growth of data warehouses and the direct access of information from various sources by managers and information users.

The scholars of information quality seem to agree on the information quality variables. Fisher et al. (2001:110) state the most frequently used information quality variables as accuracy, timeliness, consistency, completeness, relevancy and fitness for use. Whilst, Michnik et al. (2009:850) adopt the (Wang and Strong, 1996) approach of information quality representation aspects: intrinsic, contextual, representational and accessibility. Lee et al. (2002:134) also group the information quality dimensions into four categories: intrinsic, contextual, representational and accessibility.

Table 2-1 indicates the view of information quality from (Wang and Strong):

	Intrinsic	**Contextual**	**Representational**	**Accessibility**
Wang and Strong	Accuracy, believability, reputation, objectivity	Value-added, relevance, completeness, timeliness, appropriate amount	Understandability, interpretability, concise representation, consistent representation	Accessibility, ease of operations, security

Table 2-1: Information Quality Dimensions

Source: Lee et al. (2002)

2.6. Strategy Implementation

The utility is facing numerous shortcomings and challenges in implementation of its equipment reliability improvement strategy in the coal fired power stations. The poor strategy implementation can be attributed to a number of factors which comprise of human and technology elements. Literature indicates that studies have been done in many industries, on the factors hindering the success of strategy implementation. The following sub-section covers the identification of these factors.

2.6.1. Strategy Implementation Obstacles

Aaltonen & Ikävalko (2002:417-418) determine the link of the planned strategy and realizing strategy as strategy implementation. The main focus areas during strategy implementation are communication, interpretation, adoption and action. Their research concluded on the following notes:

1) Two-way communication with all levels of employees was emphasised as crucial;
2) Middle management having a pivotal role in strategy communication;
3) Managers' required to encourage different actors to consider their role in strategy implementation;
4) Organisational structure alignment with the strategy implementation was regarded only slightly problematical; and
5) The contemporary challenges for implementation lie in the communication and cultural aspects of the organisation.

The research concept for Aaltonen & Ikävalko's study is captured in the figure below.

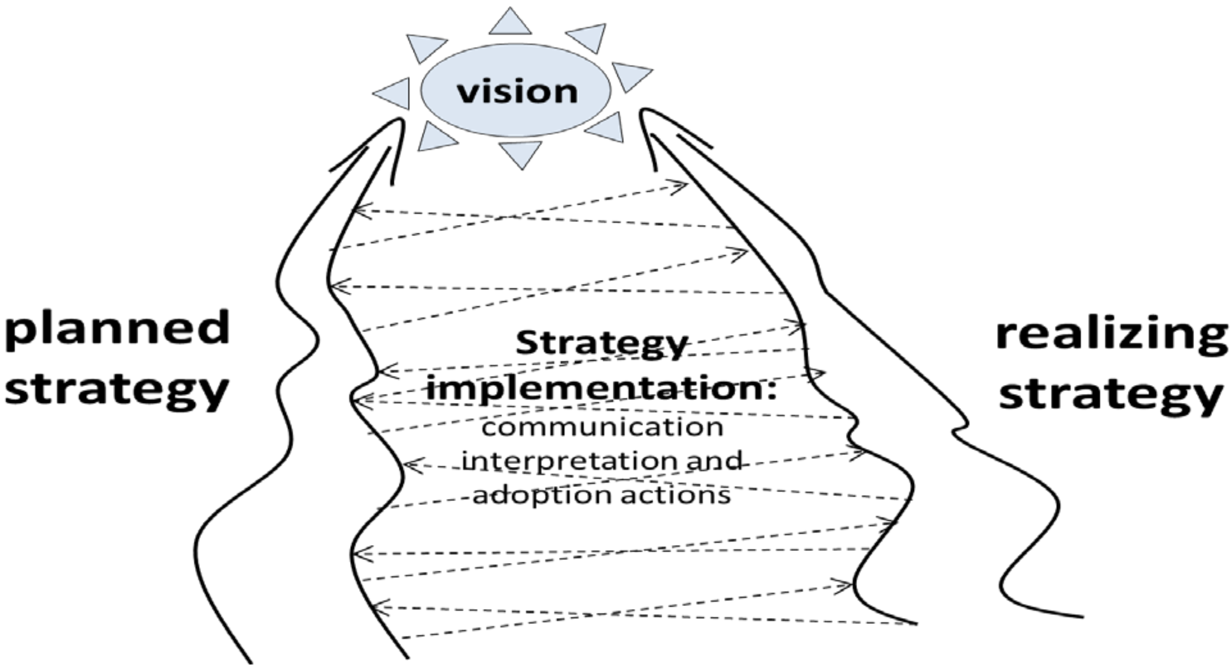

Figure 2-5: Strategy implementation as a link between planned strategy and realizing strategy

Source: Aaltonen et al. (2002)

The literature on the implementation of strategies that aim to improve both maintenance effectiveness and efficiency indicate that well documented strategies fail due to various obstacles.

In the UK, manufacturing organization Bamber, Sharp and Hides (1999:167) identify factors of failure in the early stages of implementation as the following three major attributes or obstacles: *lack of management support*, *lack of sufficient training* and *failure to allow sufficient time*. In an Indian manufacturing organization, Ahuja & Khamba (2008:131) classify the various obstacles hindering the organization's quest for achieving excellence through Total Productive Maintenance (TPM) initiatives as organizational, cultural, behavioural, technological, operational, financial, and departmental difficulties or barriers. Furthermore, Ahuja et al. (2008:135) observe that Indian manufacturing organisations have faced strong resistance from within, and have suffered due to absent organizational cultures, inappropriate maintenance improvement initiatives, low skill and knowledge of operators, inadequate resources, and poor work environments.

According to Atkinson (2006:1446) effective communication throughout the organisation leads to a clear understanding of key roles and responsibilities of all stakeholders. This is also identified among the key issues that affect successful strategy implementation.

Chan, Lau, Ip, Chan & Kong (2003:91) conducted a research on the effectiveness and implementation of the TPM programme for an electronics manufacturing company and encountered resistance to TPM by production people due to lack of TPM know how, TPM development team morale affected due to lack of production involvement, resentment towards TPM supporters due to lack of long-term vision and delayed TPM implementation progress due to lack of operation employee training. Additionally, Heide, GrØnhaug & Johannessen (2002:226) find communication problems as the main class of strategy implementation barriers. Hrebiniak (2006:16) identifies the top five obstacles to strategy implementation as *inability to manage change effectively*; *poor or vague strategy*; *not having a model to guide implementation efforts*; *poor or inadequate information sharing and unclear responsibility and accountability*; and *working against the power structure*.

One can conclude that based on the above from different industries views, the main key factors of strategy implementation obstacles are:

- Inability to manage change effectively;
- Lack of management support,
- Internal resistance;
- Communication problems; and

- Lack of sufficient training.

The literature on strategy implementation also elaborated on some identified success factors, which are covered in the next section.

2.6.2. Strategy implementation success factors

In the Indian manufacturing industry Ahuja et al. (2008:135) state that the successful implementation of TPM initiatives requires top management support, commitment and involvement. Top management should also go all-out for evolving mechanisms for multi-level communication to all employees explaining the importance and benefits. The summary of enablers and success factors are presented in the figure below.

Somers & Nelson (2001:1) explain that to ensure successful implementation of a new system the following factors must be emphasised commitment from top management, reengineering of the existing processes, integration of the new system with other business information systems, selection and management of consultants, and employee training on the new system.

The enablers and success factors for TPM implementation in the Indian manufacturing organisation are represented in the figure below.

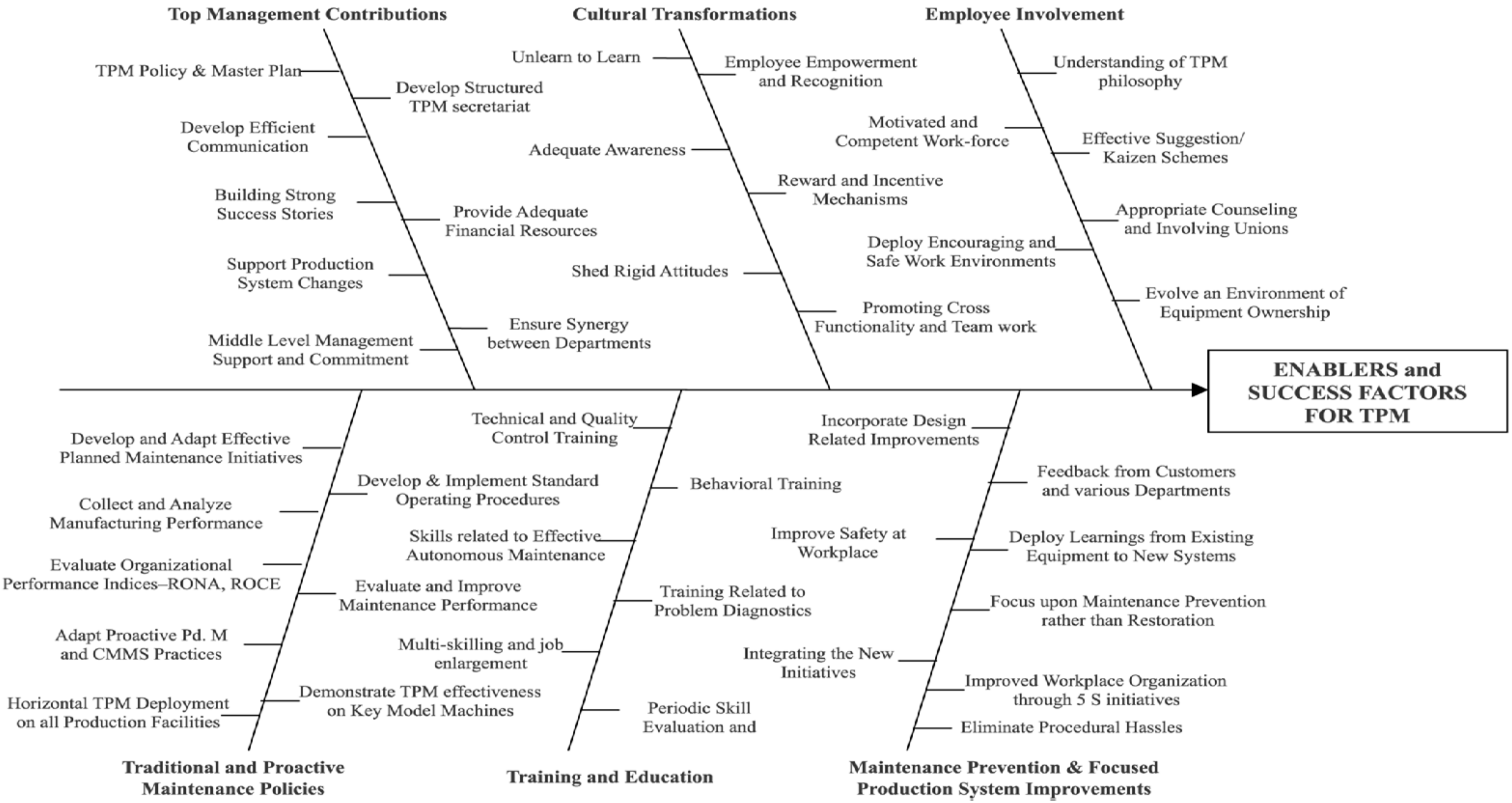

Figure 2-6: Enablers and success factors TPM implementation in the organisation

Source: Ahuja et al. (2008)

Maintenance optimisation has been regarded as a significant change to organisation structure, processes, new expected behaviours and new maintenance technology applications. To help ensure the success of the organisation, it is very important to apply change management techniques.

2.7. Change Management

In the literature the inability to manage change effectively is one of the main key factors of strategy implementation obstacles. In order to be able to manage change we first of all have to understand change. The Oxford English Dictionary defines change as 'make or become different'. In literature, change management is defined as a process that keeps organisations efficiently on a competitive front in the ever changing competitive environment. Hrebiniak (2006:16) states that the topmost ranked obstacle that managers encounter in implementing strategies is the inability to manage change and reduce resistance to new strategy implementation. The effect of change management on strategy implementation is of concern for this research study. This subsection of the literature review therefore aims to cover the significance of change management on strategy implementation within the power generation context.

2.7.1. Definitions of Change Management

Moran and Brightman (in Todnem (2005:369)) define change management as *'the process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers'.* In addition, Lorenzi (2000: 118) defines change management as the process by which the organisation vision is attained. Meanwhile, Gill (2003:309) defines change as *"a process of taking an organisation (or a nation) on a journey from its current state to a desired future state and dealing with all the problems that arise along the journey".*

The effective strategies and programs enabling the achievement of the organisation's new vision are comprehended within change management.

2.7.2. Effect of Change Management on Strategy Implementation

Organisations need to change and develop in order to remain competitive and successful in the continuously evolving environment. McNish (2003:203) states that human desire to change seems to be outpaced by technological change; also that organisational entities linking investments to corresponding change management initiatives appear to realise the greatest benefits. Lorenzi (2000:116) explains that introduction of new systems in the organisation affect more heterogeneous groups of people and organisational areas, resulting in behavioural challenges which are larger than technical challenges, for the system to succeed. Moreover, Lorenzi (2000:120) further identifies four different types of change namely operational, strategic, cultural and political change, which have impacts at different levels of the organisation. Burnes (2011:448) describes the effect of organisational change in one's life in-terms of cost, quality and availability of the services and goods such as energy, food supplies, and other vital raw materials relied upon.

2.7.3. Change Management Implementation Frameworks

Todnem (2005:378) concludes that an effective empirical framework for change management is required for contemporary organisations, since the currently available theories and approaches, in academia and in practice, are contradictory and confusing, mostly with lack of empirical evidence and based on unchallenged organisational change management nature hypotheses. Furthermore, Lorenzi (2000:122) explains that change barriers are diverse in nature and tend to affect every aspect of the organisation. Thus, a number of strategies need to be deployed to overcome the barriers at the same time, creating a complex situation of planning, monitoring and controlling. The proposed approach is to focus on one or two strategies until they become part of the normal way of operating. Only then is it time to introduce another strategy. In this way, over time, the organization gradually improves its abilities to learn rapidly, to adapt to new conditions, and to embrace change. The lack of change management implementation frameworks has led leaders to use hard strategies such as demands, threats or pressure, in response to subordinates' resistance *(*Klonek, Lehmann & Kauffeld, 2014:7). Additionally, Dunphy and Stace, as quoted by Burnes & Jackson (2011:134) argue that: *'…managers and consultants need a model of change that is essentially a 'situational' or 'contingency model', one that indicates how to vary change strategies to achieve 'optimum fit' with the changing environment'*. Literature indicates low success rates in most of organisational change efforts, which can also be attributed to lack of practical change management implementation frameworks. There is substantial evidence that some 70% of all change initiatives fail. Burnes & Jackson (2011:132).

2.7.4. Change Management Initiatives Failure

There is an indication of high failure rates in the implementation of change management initiatives in the literature. Burnes & Jackson (2011:158) conclude that among the many factors, poor planning and lack of competence by those who manage change are responsible for the high failure rate cited in literature. Furthermore, Burnes (2011:446) states that the rate of change initiatives failure far outweighed the success rate, over the last 40 years.

Gill (2003:308) further confirms poor management; poor planning, monitoring and control; lack of resources and knowledge and incompatible corporate policies and practices as contributing factors to change programme failure. However, Price (2003:237) traces most change processes failures back to poor communication and underestimation of the retraining amount required.

The summary of the factors contributing to change management initiatives failure are in line with the obstacles of strategy implementation, it is interpreted that overcoming the strategy implementation obstacles results in understating, acceptance and internalization of the strategy by the affected people.

2.8. Human Dynamics

"…there is nothing more difficult to take in hand, more powerless to conduct or more uncertain in its success than to take the lead in the introduction of a new order of things…"

Machiavelli 1993

Kitchen & Daly (2002:46) explain that in the twenty-first century the new dynamic revolutionary business environment continuously changes. The continuously changing external and internal factors such as, globalisation, deregulation, privatisation, mergers, acquisition, movement of labour towards less expensive economic locations, coupled with revolutionary advances in technology and simultaneous empowering of consumers coupled with changes in demand; is forcing organisations to continuously re-evaluate its strategies in order to remain competitive. The realisation of effective human consideration in organisational changes would enhance level of acceptance by those affected. Organisations are made of people and without people the organisation cannot exist. Change has been seen to affect people differently regardless of the level in the organisation; whenever change is introduced there is a combination of responses to be expected from people namely acceptance, undecided and resistance the change. Proctor & Doukakis (2003:268) explain that when people perceive loss to an introduction of change, that usually raises resistance. The human factor in any strategy implementation plays an important role in the success of the strategy; this subsection of the literature review therefore aims to cover the factors hindering the strategy implementation success from a human factor perspective.

2.8.1. Communication

For a thorough understanding of the effect of communication on human behaviour towards "change", communication has to be defined. The Oxford Dictionary definition of communication is *"The imparting or exchanging of information by speaking, writing, or using some other medium"*. The primary source of resistance to change has been identified as perceived loss, effective communication of the benefits and necessity of the initiative to the affected plays an important role in overcoming resistance, assuaging fears, minimising confusion and buy-in by all affected individuals. Kitchen & Daly (2001:47) state that in current business management literature the identified instrumentals in terms of organizational growth and survival are management of knowledge, employees and internal communication. Lorenzi (2000:117) observes communication deficiencies as one of the most important causes of strategy implementation failures. Aladwani (2001:270) states that the benefits of the strategy implemented must be communicated effectively to the workers for the success of the implementation by top management. Whereas, Aaltonen & Ikävalko (2002:417) state that successful strategy implementation is not guaranteed by sufficient communication only, interpretation, acceptance and adoption among implementers are also crucial. Gill (2003:308) emphasises that lack of communication and inconsistent messages have the potential to demoralise people in a form of rumours resulting to a lack of commitment. Additionally, McNish (2003:209) relates to the collective organisation responsibility of effective communication of information sharing through sustainable mechanisms for the success of change.

2.8.2. Resistance

Most organisational structures marginally support integrated change process with sufficient time for knowledge awareness; resulting in imposing change on people. Innovation requires people support and acceptance; the technically best innovation can be brought to its knees by mere people resistance. In addition, Aladwani (2001:268-269) classifies the two fundamental sources of resistance to innovation according to Sheth (1981) framework as perceived risk and habit. The perceived risk refers to one's perception of the risk associated with the decision to adopt the innovation, whilst habit refers to one's current practices.

Lorenzi (2000:117) states that people are not anti-change, people have the will to change when change is introduced in an acceptable manner and not being imposed on them; imposing change triggers resistance. Moreover, Lorenzi (2000:120) explains that in order to achieve some sense of control, belongingness, and significance out of work, workers develop strategies and by management misunderstanding these strategies, unintentionally most change initiatives threaten to cause workers serious personal loss resulting to resistance. The scholars of change management cited a common view of employees being the main major contributors to change resistance.

Nonetheless, Lorenzi (2000:121) emphasises that the behaviour of the entire organisation is similar to that of individuals when faced with the needed change, as an organisation is made by people and management also have human factor towards any change implementation. However, Isett, Glied, Sparer & Brown (2012:2) argue that new research has revealed an area of opportunity in the frontline employees' position and resourcefulness to enhance the change efforts success rather than the traditional view of frontline employees being the major obstacles to change.

2.8.3. Training

In the medical industry, Isett et al. (2013:6) note that to successfully implement transformative change, management retrained existing staff to implement the new processes and conducted extensive training with new staff to understand the new roles they were to fulfil. Additionally, Jones, Jimmieson & Griffith (2005:364) note that through training and development, open communication, and participative decision-making, high levels of unity and morale among employees are harvested. Jones et al. (2005:365) further explain human relations orientation of an organisation, by training and development of its human resources, relating to an employee's confidence and capability to undertake new workplace challenges. Moreover, Aladwani (2001: 271-272) notes the attributes of training, in implementing an ERP system, as a good opportunity to help system users adjust to the change, helps build positive attitudes toward the system and provides hands-on experience for the users: they appreciate the quality attributes of the system and its potential benefits. In support, Fui-Hoon et al. (2001:293) explain the essence of training to be for employees to understand how the system will change business processes.

However, Lorenzi (2000:123) states that organisations that fail to explore training or changes in structures, procedures, and management practices struggle in improving organisation processes.

Also, Price et al. (2006:250) mention poor communications and failure to appreciate the amount of retraining that is required as the underlying reasons to failure in most change processes. Somers et al. (2001:2) support this in mentioning that ERP implementation problems and failure are associated with lack of user training and failure to completely understand how enterprise applications change business processes frequently appear.

2.9. Management Contribution

Todnem (2005:369-370) describes the consistently changing environment and technology, which demands organisations to adapt to the required change. The nature of change and the aspects that trigger the need for change, has given a view of organisational change leadership being the primary task of management. Mento, Jones & Dirndorfer (2010:58) go as far as to conclude that *'the 21st century change leaders is that they must be astute decision makers and marketers, trusted innovators, agents of change, preachers of difficulties, master integrators, enterprise enablers, technology stewards and knowledge handlers'*.

2.9.1. Management Focus

McNish (2002:201-202) further states that traditionally the main focus of management has been technical and financial details of any form of change; the associated human factors are normally overlooked. The human factor consideration is normally realised at the point of implementation failure; which should have been built-in at the initial development stage of the strategy to implementation plan. Furthermore, another aspect that management gives less attention to is the required learning period of the novel and complex technologies, when pursuing new sources of major competitive advantage. Traditionally management visibility in strategy development is dominantly more visible than during the strategy implementation phase. Management focus has to change from the development of strategies, which frameworks have been developed over the years, and give much attention to the implementation of strategies as there is still a big gap between the conceptualised academic frameworks and practical application of these implementation frameworks.

2.9.2. Management Support

Hrebiniak (2006:13) articulates the management responsibility in the implementation of the strategy, as the '*key responsibility of all managers, not something that ''others'' do or worry about.* Weinstein et al. (2009:505) further elaborate that the critical success factor, of strategy implementation of a maintenance programme, is top management support. Isett et al. (2012:3) mention that leaders' consistent support and sustained attention are important dynamics to be considered in change initiatives. Additionally, McNish (2002:209) emphasises on the dependency of the success of a project on a habitual consistency of top management support cultivation.

Likewise, Gill (2003:308) states ways in which management commitment can be evident as:

1) Their unequivocal acceptance of ownership and responsibility for success of the change initiative; Eagerness to be involved; Willingness to invest resources; Willingness to take tough decisions when required; Awareness of the impact of their own behaviour; a consistent message; and the holding of regular reviews of progress.

Aaltonen et al. (2002:417) further concludes that continuous two-way communication with feedback and reaction to bottom-up messages can achieve an understanding of the strategy. While change must be well managed - it must be planned, organised, directed and controlled - it also requires effective leadership to introduce change successfully: it is leadership that makes the difference Gill (2003:307). However, Lorenzi (2000:116) states that behavioural resistance to new technologies can be sharply reduced through effective leadership. Lastly, Raelin & Cataldo (2011:504) conclude that ensuring interaction crosses systems prevents change initiatives failure; middle managers must consider social empowerment very critical.

2.10. Conclusion

This Chapter presented the theoretical background underpinning the research.

The review showed that a lot of study has been done in trying to develop maintenance optimisation models. The maintenance optimisation models have been classified as quantitative and qualitative approaches to improve equipment reliability. Some researches even went as far as coming up with mathematical models that support the existing maintenance optimisation models. The researchers used first and second order reliability analysis to formulate the mathematical models. The review also noted that researchers are in agreement that the baseline maintenance optimisation strategy is based upon the reliability centred maintenance principles. The literature also pointed out the importance of CMMS information completeness and accuracy. The review on strategy implementation noted that the main key obstacles are rooted in change management and human dynamics. The realised gap in change management literature is the lack of practical implementation frameworks.

3. CHAPTER 3 – CONCEPTUAL FRAMEWORK

3.1. Introduction

In the previous chapter the theoretical background underpinning the research in the power generation sector was presented. Secondly the functions of the Computerised Maintenance Management System were found in literature and were also presented. This was for the purpose of indicating the fundamental functions of a CMMS within power station operations. Furthermore the effects of change management in strategy implementation were highlighted.

This chapter seeks to develop a broader level of understanding of the research problem, by using conceptualised Asset Management Improvement (AMi) model. The conceptual framework encompasses: Reliability Basis Optimisation Model; Work Management Model; and Continuous Improvement. The Reliability Basis Site Implementation Process at power stations was the main focus to address the research study objectives discussed in Chapter 1.

3.2. Reliability Basis Optimisation (RBO) Model

The Reliability Basis Optimisation Model is a four step process that involves development of best practice GGCS templates, site analysis, reliability basis implementation and continuous improvement. To achieve the full benefit of reliability optimisation, the steps should be completely implemented at the power stations. It must be noted however that these steps might not apply comprehensively and have therefore been tailored specifically for power generation sector. The figure below illustrates the steps of reliability basis optimisation model.

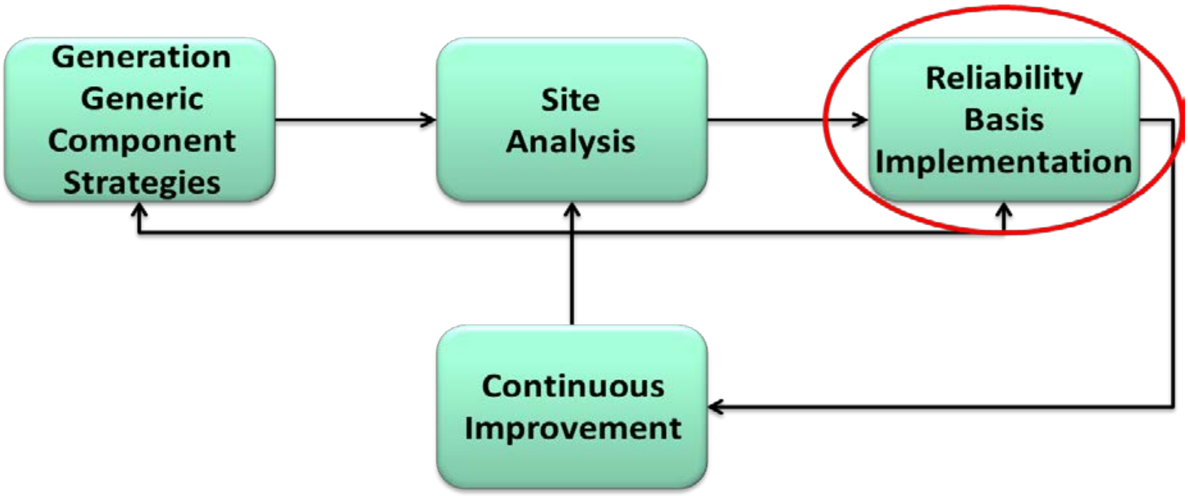

Figure 3-1: Reliability Basis Optimisation Model

Source: Eskom (2007)

3.2.1. RBO Process

RBO is the process used to determine and record the basis of monitoring and preventive maintenance activities on equipment. The critical plant assets are identified and protected from failure, by specifying and utilising the most cost-effective methods to manage failure mechanisms. The RBO process is a step-by-step approach to optimise the plant Reliability Basis. This is attained by incorporating plant specific knowledge, maintenance and failure history, and industry best practice, in order to finally achieve an effective Maintenance Strategy for each plant System and equipment type. The RBO process comprises three phases. The figure below shows the RBO process and below is the detailed step by step explanation of the process.

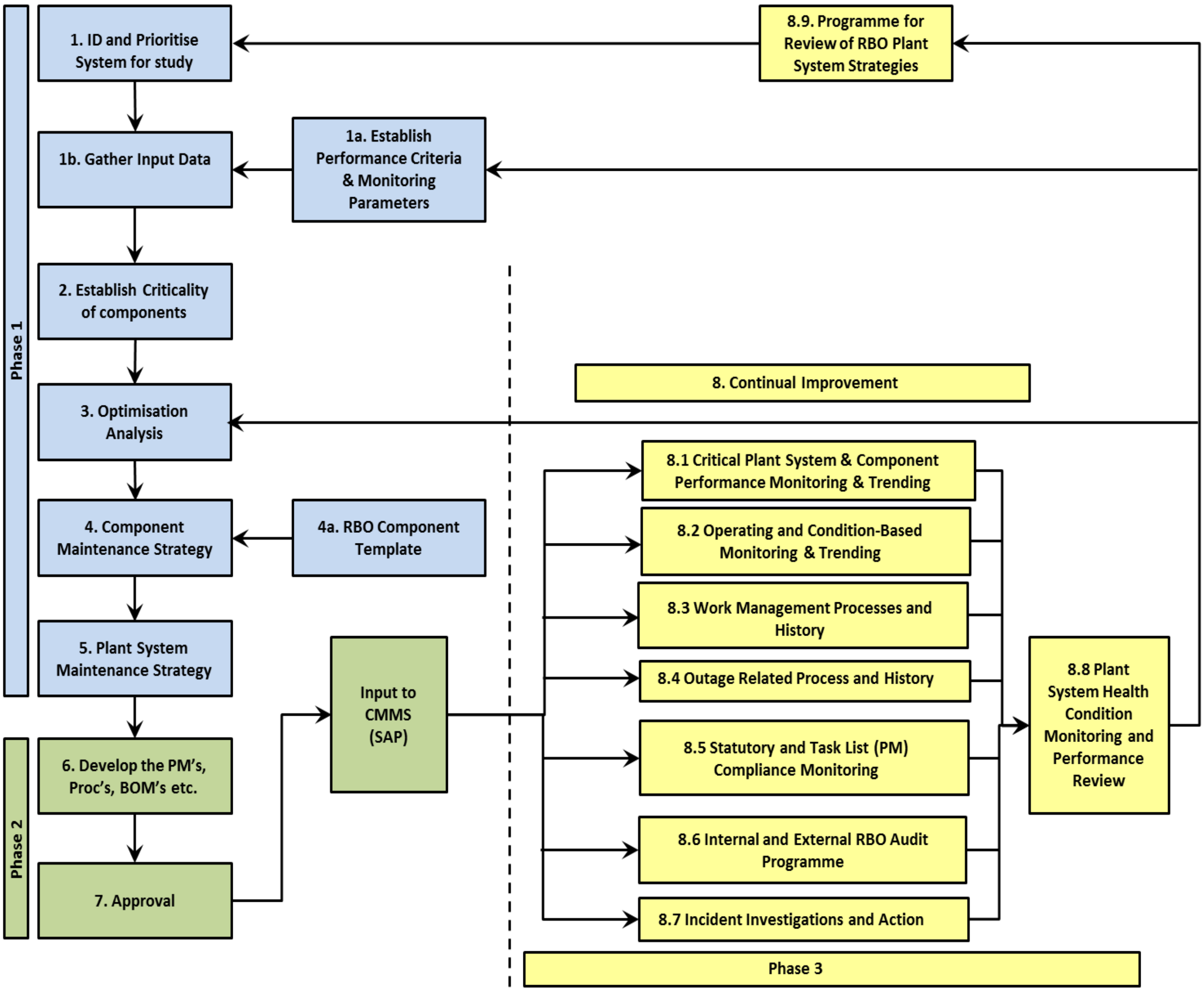

Figure 3-2: Reliability Basis Optimisation Process

Source: Eskom (2013)

Phase 1: Site Analysis

Step 1

The identification and prioritisation of plant system components by the system engineer. The system engineer identifies the boundaries of the specified System and prioritises the optimisation order of the System components. In this step the system engineer is assisted by the station management team, comprising of the RBO Corporate Site Team, station manager, engineering, operations, maintenance and RBO station coordinator. The relevant plant system data such as performance criteria and monitoring parameters are also established. The components on the physical plant are verified with a visual inspection before performing optimisation analysis.

The following data is obtained in preparation for the analysis:

- Plant hardware breakdown structure
- Plant System drawings (flow diagrams, P&ID, etc.)
- List of components to be analysed
- Component current maintenance strategies
- Maintenance and operating procedures
- Previous analyses e.g. RCM, FMECA, etc.
- PM's from identical plants in other stations (for benchmarking)
- Capital/modification plans in progress or completed
- OEM documents and/or Contracted Out Plant
- Maintenance History from CMMS
- Best Practice Maintenance Strategies Templates (GGCS)
- Desired Component Capabilities (minimum operating parameters or acceptable levels)
- Monitored Component Parameters (e.g. temperature, pressure, vibration, etc.)

Step 2

In this step the critical or functional important of the systems, such as structures and components supporting critical function, are determined. The components are categorised in relation to potential consequences (risk), by a panel of experienced staff from Operation, Maintenance and Engineering.

Step 3

The optimisation analysis is performed on each component. The analysis entails the following activities:

- Identifying duplication in existing task lists and tasks
- Identifying and removing of redundant tasks
- Reviewing frequencies based on OEM, maintenance history and templates
- Identifying similar system models from other power stations
- Search for relevant best practice maintenance strategies

The tasks that were originally instituted for valid reasons such as legal, environmental or incident mitigation are carefully considered when removing tasks. The Optimisation analysis is conducted by comparing the tasks list and tasks with similar components tasks list and tasks on other sites as well as OEM experience.

Step 4

In this process step, the RBO team, for critical and non-critical components, decide and document an appropriate new component maintenance strategy, with appropriate task descriptions and frequencies. If there is absence of Eskom and OEM experience, best practice templates and site strategies, a formal Failure Modes and Effects Criticality Analysis (FMECA) is performed to generate new component maintenance strategies.

Step 5

The system engineers compile and document a draft Plant System Maintenance Strategy document, for approval. The Plant System Maintenance Strategy includes the following strategies related to the particular plant System:

- Operating Strategy (operation, change-over and/or testing of streams, redundant and standby equipment)

- Outage Strategy (outages, outage period, pre-outage interventions etc.)
- Maintenance Strategy (component failures, failure mode and mitigation methods)
- Spares Strategy (capital or strategic spares)
- Proposed Modification (planned and based on optimisation analysis study)

Phase 2: Reliability Basis Implementation

Step 6

This process step involves a step by step process of implementing the Plant System Maintenance Strategy. The Works Management/Maintenance functions develop tasks lists for all identified tasks in the Maintenance Strategy. The System engineer reviews all task lists prior to approval by the relevant functions.

Step 7

The documents (PM's, Procedures, BOM's etc.) are reviewed and approved by relevant Department individuals after the System Engineer review. The documents are uploaded into CMMS and activated/switched on for implementation.

Phase 3: Continuous Improvement

Step 8

This process step involves a process of learning from past experience, continuous improvement, in order to further reduce future failures and improve equipment reliability. The process includes the close-out of work, maintenance feedback capture, analysis of maintenance history and making appropriate Reliability Basis adjustments.

3.2.2. RBO Objectives

The primary objective of the Reliability Basis Optimisation rationale is to establish an effective preventive and condition based maintenance programme with formalised technical basis. The following objectives form the basis of the primary objective:

- To reduce or remove functional failures of production-related equipment;
- To maximize the benefits of preventive and predictive maintenance activities;

- To achieve optimal operating and maintenance costs;
- To establish a fully documented and easily managed basis for all preventive maintenance and predictive maintenance activities;
- To enhance personnel safety, optimising equipment reliability, availability and maintainability.

3.3. Work Management Framework

3.3.1. Routine Work Management Process

Eskom's definition for routine work management is "the combination of technical, administrative and managerial actions aimed at ensuring that all work is properly identified, planned, scheduled, assigned, executed and completed in pursuit of the work management objectives." Eskom (2007). work management is a six step process which consists of two components namely routine work management and outage management. The figure below illustrates the six step process of routine work management.

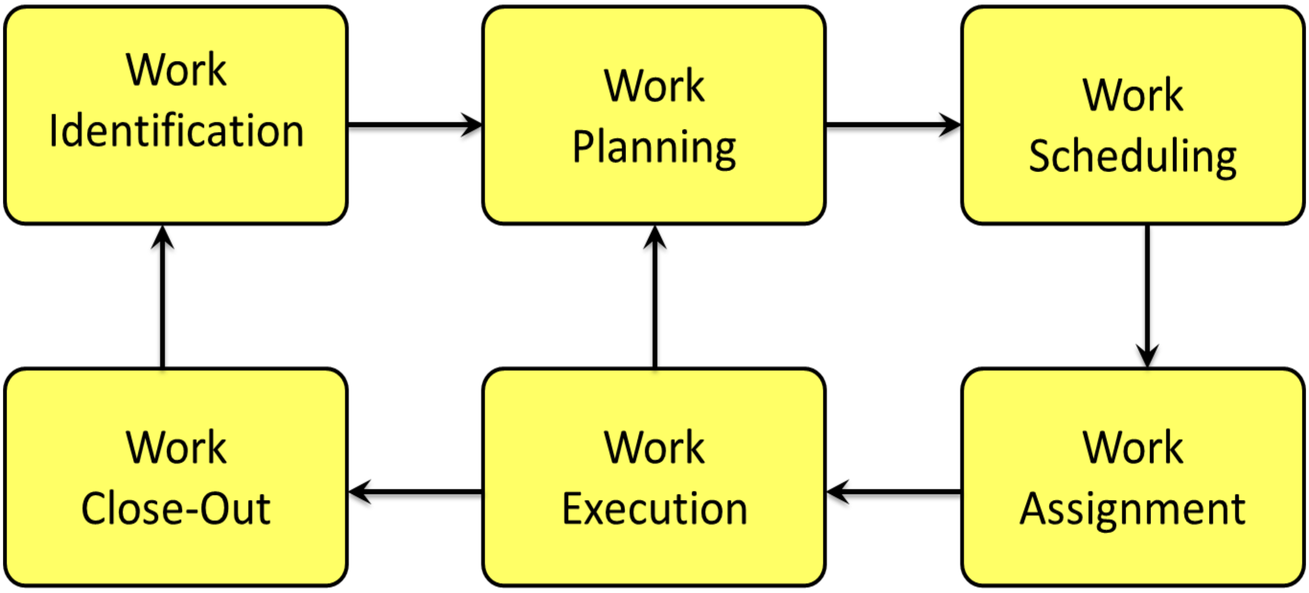

Figure 3-3: Routine Work Management Process

Source: Eskom (2007)

3.3.2. Objectives of routine work management

- Reduce critical equipment failure rates to maximize reliability

- Achieve a high utilization and productivity of limited resources by properly planning work activities, and optimizing the scheduling of work activities
- Develop and retain a committed and disciplined workforce of employees
- Be proactive in the approach to equipment reliability
- Ensure best practices and technology
- Provide consistency

3.4. Integrated Asset Management Improvement Model

The integrated Asset Management Improvement model is based on the practises that Eskom currently interprets as the “World’s Best Practice”.

The high level model is shown in the figure below

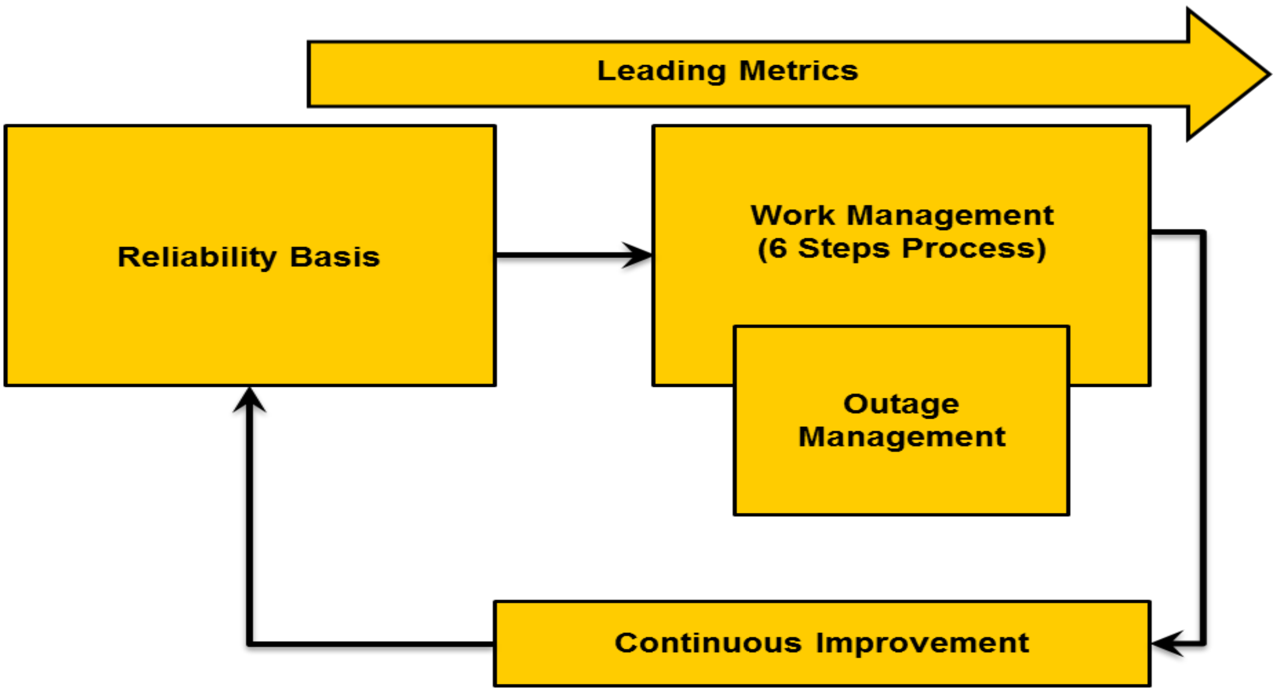

Figure 3-4: Asset Management improvement (AMi) Model

Source: Eskom (2008)

The models within the AMi model are broadly explained below.

Leading Metrics: The maintenance effectiveness is measured by the use of leading or lagging metrics.

Reliability Basis: The Reliability Basis includes documenting of all evaluated plant equipment, associated maintenance and operations activities and the frequencies at which they are applied. The Reliability Basis is the core document for all AMi model activities.

Work Management: The Work Management is the 6 step process that involves identification, planning, scheduling, assignment, execution and close-out.

Outage Management: The Outage Management is a form of work management process but specifically adapted for outage work.

Continuous Improvement: The continuous improvement is a process that adjusts plant maintenance and/or operations, as required, to achieve and maintain a “best practices” reliability organisation.

Figure below indicates interrelationship between Reliability Basis Optimisation and Work Management to improve the equipment reliability. The integrated model also includes the sub models of continuous improvement as well as outage/project assessments.

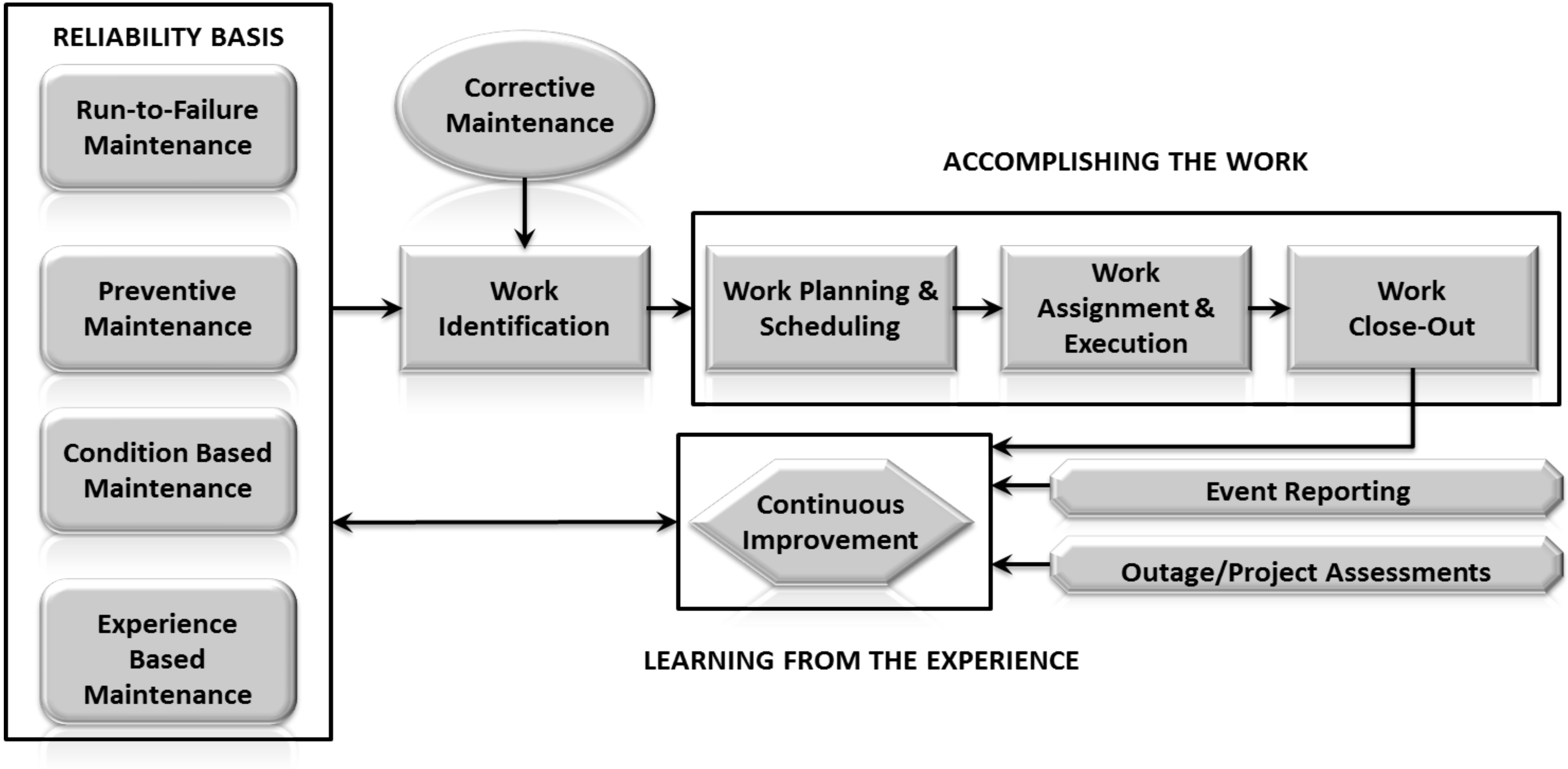

Figure 3-5: Interrelationship between the Reliability Basis Optimisation and Routine Work Management

Source: Eskom (2007)

3.5. Reliability Basis Site Implementation Process

The objective of this study is to identify the key factors hindering the implementation of the RBO strategy, related to CMMS usage and change management philosophies, in coal fired power station". In this section the Site Implementation Process Eskom utilised is discussed.

The process comprises of the following phases:

1. The preparation requirements

2. The RBO "Intensive Care" effort

3. The "Managed Care" activities

3.5.1. Preparation

In the preparation phase before starting the site work, two meetings with the station management team is to be held. The purpose of the first meeting is to ensure senior management buy-in and commitment to the RBO efforts. The station management illustrates commitment by resource allocation. The initial 3 to 4 plants to be analysed are confirmed and agreed upon. The meeting is to be held one month before the commencement of the onsite RBO activities. The second meeting is to be held two weeks before the start of the onsite RBO activities. The purpose of the meeting is to assure logistics, data, information and resources will be available for the on-site RBO activities.

3.5.2. RBO "Intensive" Care

The intensive care effort requires 8 to 10 weeks of full time activities to develop a Maintenance Strategy for the specified plants, with a minimum of 3 plants for analysis. In the first day of the intensive care effort, a 2 to 3 hours training is conducted for RBO Corporate Site Team, Plant Management (at own discretion), RBO Station Coordinator, Station System Engineers for the initial plants scheduled, Maintenance (Mechanical, Electrical and C&I) and Operation personnel of the initial plants scheduled. Other System Engineers, Supervisors, Planners, Operation and Artisans attend the training at the discretion of management. Subsequently, the RBO analysis tasks are done in 3 working sessions for each plant.

a) Session 1 – RBO Plant Analysis Planning

The plant boundaries are defined in this one day session. The equipment and their components /parts to be analysed are established and critically ranked.

b) Session 2 – RBO Plant Station Knowledge/Experience for each Engineering Discipline

The knowledge/experience of the station experts is captured in this 2 days session. The approach deployed to capture knowledge is the Failure Mode Analysis (FMA) process. If there is absence of Eskom and OEM experience, GGCS templates and site strategies, a formal FMA is performed to generate new component maintenance strategies.

c) Session 3 – RBO Plant Maintenance Implementation Strategy Session

In this session the maintenance strategies compiled in session 2 are summarised and compared to the GGCS templates. If there are differences between the maintenance strategies and GGCS templates, the reasons for the differences are documented, analysed and justified. Furthermore, the Maintenance Strategy Document and the outline of the implementation plan for the specific plant are prepared. The plan documents, the maintenance strategy and details of implementing the strategy into CMMS.

3.5.3. RBO "Managed" Care

In completion of the full time Intensive Care effort, site support from the Corporate RBO Consultant will be on a part time basis. The RBO Station Coordinator and System Engineers support the implementation of the Maintenance Strategy developed under Intensive Care effort. The Corporate RBO Consultant provides continuous support and training of the station personnel in the development of Maintenance Strategy for new Plants. The latest GGCS templates and Maintenance Strategies developed from other stations are made available. The time frame for Manage Care effort is approximately one week per month for a year. Offsite support of 8 hours per month is provided by the Corporate RBO Consultant.

3.6. Conclusion

The models that are applicable in the development of a conceptual framework are presented in this chapter. These are the Reliability Basis Model; the Work Management Model; and the Asset Management improvement model adapted from the literature and industry best practices. The models that have been used are not considered "new" and have been evolving as has been the maintenance strategies as indicated in the literature review. These models have led to the development of the Site Implementation Process which is also focused on in this chapter.

The framework firstly focused on the Reliability Basis Optimisation as a process and secondly linked the Work Management process with the RBO process in order to reduce critical equipment failure rates, which can enhance the plant reliability and performance. The integrated model, incorporating outage management and continuous improvement with leading metrics, concluded the AMi model for power generation sector. The development of the appropriate research design and methodology to achieving the research objectives will be defined in the following chapter.

4. CHAPTER 4: RESEARCH METHODOLOGY AND DESIGN

4.1. Introduction

The Reliability Basis Optimisation (RBO) processes discussed in chapter 3 provide the framework to investigate the key factors hindering the RBO strategy implementation in a coal fired power station environment. The primary objective of the RBO strategy as presented (in section 3.2.2) is to improve equipment reliability, in turn optimise availability and maintainability. The expected outcomes of this research study were derived from two main focus areas, namely the use of the CMMS by end users and the applied Change Management philosophies during RBO strategy implementation.

The objective of this chapter is to describe the research method applied, in order to achieve the research objectives stated in section 1.4. Furthermore, this chapter describes the research fundamentals and properties that led to the research design chosen. The sampling method, research instruments used, data collection methods and research reliability and validity are discussed in this chapter. The overview of the research study is described below for the elementary understanding of the research method and design fundamentals followed.

4.2. Research Overview

The purpose of this research study was to recognize significant aspects hindering the complete implementation of the RBO strategy in a coal fired power station. The main focus areas for this research study were grouped into two main categories namely, the use of the CMMS by end-users and change management philosophies employed in the inception of the RBO strategy implementation phase. The selection of the research method and design took consideration of the site implementation process presented (in section 3.5).

In addition the study intends to draw conclusions and recommendations in the end, which could be used as a guideline when implementing imported strategies in future. This will be achieved through:

- Defining the current level of CMMS usage by RBO strategy implementing personnel.
- Establishing the level of quality of information retrieved from the CMMS by RBO strategy implementing personnel.
- Assessing the elements of human dynamics that are considered during on-site implementation of the RBO strategy.

- Evaluating the extent of management contributions during on-site implementation of the RBO strategy at the power station.
- Gathering recommended future improvements of implementing similar strategies in a power station environment.

Research Methodology

The diagram below maps out the research methodology followed to achieve the set research objectives.

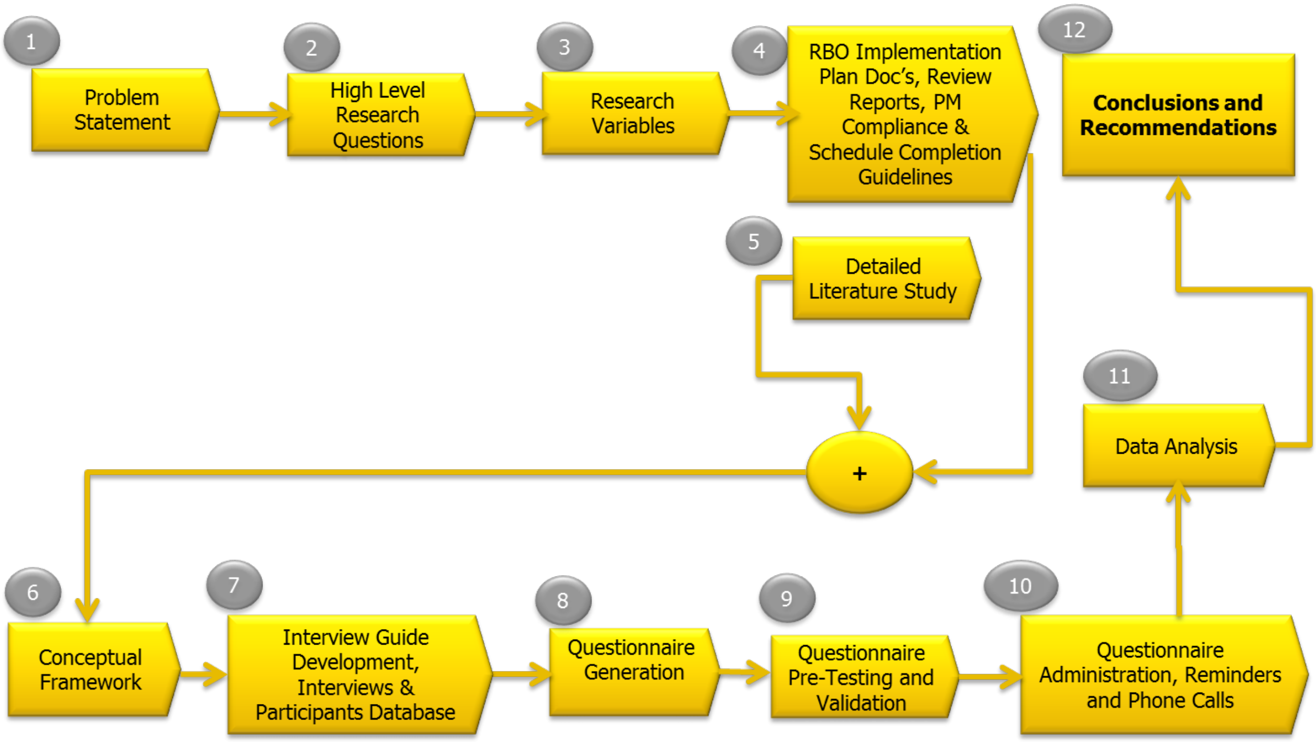

Figure 4-1: Research Methodology Road Map

The research study was formulated by describing a problem statement. The problem statement described the research fundamental basis. This led to a few high-level questions which elaborated further to research objectives and identified the research variables. These formed the basis of achieving the research objectives. Thereafter, a comprehensive literature review and existing reports reviews were performed to obtain the fundamental basis of the research topic. The literature was firstly limited to coal fired power stations (similar environments), where literature was considered inadequate other industries were considered to formulate the required theory base (i.e. strategy implementation success and failure factors).

A substantiated field research of semi-structured interviews, survey questionnaires and a power station case study was conducted. The comprehensive discussion of utilised research instruments is provided in section 4.4.4.

The interview guide was developed based on the literature and report reviews. Thereafter, in-depth semi-structured interviews were conducted with power station RBO strategy implementation management. The interviews were recorded (with the permission of the interviewee) and the responses were analysed. The participant's database was established and a questionnaire developed.

An on-line survey questionnaire was created on www.surveymonkey.com. The survey questionnaire was distributed to a pre-selected small sample of 12 respondents for pre-testing and validation. The respondents were selected purposively and all showed enthusiasm in participating in the pre-test. The researcher clearly informed the respondents, which were not part of the target population, about the intent of this exercise. Where questions were not understood the researcher edited and send back to the sample.

Thereafter, the survey questionnaire was distributed to the identified population of self-selected respondents. Furthermore, a detailed analysis of collected data is presented later in the following chapter. The conclusions and recommendations are provided on the identified challenge areas in implementing such a strategy in a power station environment.

Section 4.4 covers the research strategy that was utilised as a guideline to conducting the research study.

4.3. Research Strategy

Page et al. (2000:19) define research strategy as *"…the type of research being conducted and the purpose of it".* Despite the many purposes of conducting a research, the final outcome is either categorised as purely scientific purpose of adding to a body of knowledge or for the purpose of reducing or solving some specific problem.

The types of research strategies that can be conducted are as follows (Page et al. 2000:19-20):

- *Pure research* is conducted by industries for the purpose of adding to the body of knowledge about the industry that they are in.

- *Applied research* is conducted with as specific application in mind by managers to solve specific organisational problems.

- *Action research* focuses on taking action as a result of findings, set within a long-term cyclical process.

- *Evaluation research* is used where there is a desire to effect ongoing development change, monitor results, and determine whether and where further change is required.

Upon the selection of one of the strategies mentioned above, for the purpose of gathering information the study is categorised into the following types (Page et al. 2000:22):

- *Descriptive studies* describe a phenomenon or event as it exists without manipulation or control of any of the elements involved in the event under study.

- *Exploratory study* looks for ideas, patterns or themes by exploring an issue or problem that exists.

- *Comparative study* is the comparison of research findings with what is expected in theory, and experimental groups with control groups.

- *Hypothesis-testing study* uses statistical techniques to test whether research findings do or don’t support the predictions arising from the theory at statistically significant level.

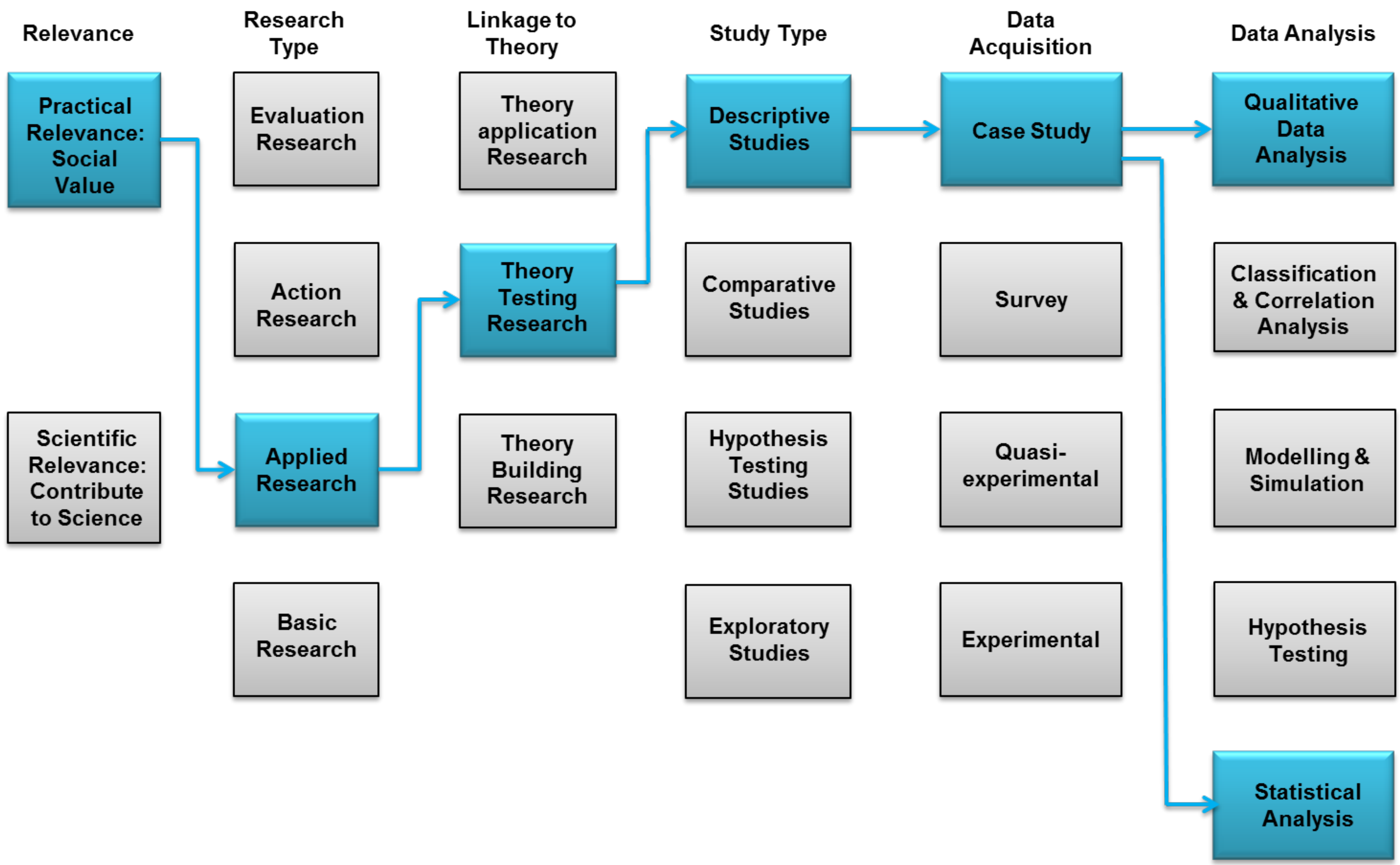

Figure 4-2: Research Strategy

4.4. Research Design

The research strategy above indicates that the research study characterised the elements of a descriptive research. According to Hair, Money, Samouel & Page (2007:155) a research aimed to obtain data and describe the characteristics of the topic of interest is a descriptive research.

In this study a descriptive and analytical cross sectional study was undertaken with power station personnel responsible for the implementation of the RBO strategy at the power station during the study period. The study is descriptive because the researcher wants to gain insight of the significant focus areas impeding the implementation of the RBO strategy, related to CMMS usage and change management philosophies application. Furthermore, the researcher chose the analytical cross sectional study because the outcomes and characteristics are measured in a specific point in time and analysed quantitatively. The collection of empirical data from sources requires a defined target population. The following section describes the definition of the research population for this study.

4.4.1. Research Population

Hair et al. (2007:173) define the target population as a complete group of objects or elements which the researcher consider relevant to possess information required to be collected. The objective of the research was to infer the population characteristics from the sample.

According to Page & Meyer (2005:98) generalisation of research findings from the sample to the population requires probability sampling. For the sample to be representative, it must exhibit the characteristics of randomisation and stratification. These characteristics reduce the level of bias and sampling error and increase the level of confidence that the sample is representative of the population.

The population of this research study was limited to the following criteria:

- Respondents had to be working in departments involved with the implementation of the RBO strategy
- Departments had to have actively implemented the RBO strategy

The population of this research study was limited to engineering, maintenance and works management personnel at the power station of interest. The population was expected to have been involved in the implementation of the RBO strategy. The objective was therefore to afford the entire population an equal opportunity to respond to this research. In this study a population of 75 employees was studied which consisted of 51 engineering personnel, 7 maintenance personnel and 17 works management personnel.

4.4.2. Sampling Design

A non-probability sample method, namely purposive sampling, was chosen for this research study. Tongco (2007:147) explains purposive sampling as a non-random technique whereby the researcher decides what needs to be known and find the people who are willing to provide the information by virtue of knowledge or experience. The entire population was given an equal opportunity to participate in this research study, in accordance to their different departments. This decreased the possibility of a high level of bias and sampling error.

4.4.3. Determining of Sample Size

Buys (2013) indicates that population size has no impact on the determination of the sample size. The determination of a sample size for large populations involves the probability of getting similar results when the survey is repeated (confidence level) and the estimated level of inaccuracy associated with the sample results (confidence interval). The determination of the sample size with these factors indicates the effectiveness of the sample observations.

According to Buys (2013) for management research studies the confidence level (CL) is 90% and confidence interval (CI) 10%. The sample size determination is also depended on the sample design chosen. Buys (2013) calculates the sample size for stratified random sample with CL=90% and CI=10% as 58.

The provided minimum sample size formula is as follows:

$$\boldsymbol{SS_{small} = SS_{large}/(\,1 + \frac{SS_{large}-1}{Population})}$$

Equation 1: Sample Size

Source: Buys (2013)

$$SS_{small} = 58/(\,1 + \frac{58-1}{75})$$

$$= 32.95 \approx \mathbf{33}$$

In this study purposive sampling was employed. The list of personnel in the departments of interest was obtained from the power station. The survey questionnaire was distributed to the entire target population through an online survey www.surveymonkey.com. The response rate was too low after two weeks of distributing the questionnaire. The researcher sent online reminders and e-mails coupled with a number of telephonic follow-ups. The researcher went on-site and collected the data through face to face request of participation in the research study.

A total of 47 employees accepted the invitation and responded in the survey questionnaire. All the respondents were assured of their anonymity and also that the results would be used solely for academic purposes.

4.4.4. Research Instrument

The research instruments used in this research study, for the purpose of collecting primary data, were semi-structured interviews and survey questionnaires. The semi-structured interviews were conducted on a limited sample and the questionnaires were distributed to the entire target population.

4.4.4.1. Semi-Structured Interviews

The participants were selected management personnel from different departments involved in the RBO strategy implementation. E-mails requesting interview meeting were sent to 10 identified participants who were either middle managers or senior managers in engineering department, work manage department and maintenance department. A total of 2 middle managers and 3 senior managers accepted the invitation and participated in the interviews.

The interview guide had an introductory cover page explaining the research purpose, structured questions related to the research variables and a closing comment. The interviews were recorded with permission of the interviewee.

The criteria developed for this sample determined the above said number. The participants that were interviewed were based on their availability on the basis of the research time frame. The criterion employed for the selection of the participants sample was:

- Managers who are tasked with ensuring the complete implementation of the RBO strategy.

The main objective for conducting these interviews was to:

- Acquire comprehensive understanding of underlying key hindering factors, in the identified focus areas from the literature and report reviews e.g. communication; and
- Compare the views of the employees to that of management.

4.4.4.2. Survey Questionnaire

The secondary research instrument was a survey questionnaire. The questionnaire had an introductory cover page explaining the research purpose and the questions were in a structured format. The questions were categorised in six sections. The first section (Section A) covered the demographic characteristics of the respondents, Section B assessed the use of CMMS by respondents, Section C assessed the degree of information quality retrieved from CCM System, Section D assessed human dynamics considerations in the implementation process, Section E assessed the management contributions in the implementation process and Section F enquired about the endorsed future improvements of similar strategies. The questionnaire was formulated from the interview results, literature and report reviews.

The survey questionnaire was distributed to the entire target population through an online survey www.surveymonkey.com. The questionnaire was pre-tested and validated with a selected group of 12 system engineers. The respondents were selected purposively and all showed enthusiasm in participating in the pre-test. The researcher clearly informed the respondents, which were not part of the target population, about the intent of this exercise. The following observations were noted by the researcher:

- The respondents interpreted the questions well, even though Section B questions were not fully understood when referring to CMMS as CMMS. The researcher then decided to use the name of the currently used system by the organisation (SAP PM). The intention was not to name any specific system as there are different systems defined as CMMSs. This was noted as a limitation and is discussed further under the limitations.

- The questionnaire took less than 30 minutes to be completed and the research concluded that completing the questionnaire would not be time consuming and tedious for respondents.

The link to the online survey questionnaire was provided in the distributed questionnaire email. The population was later reminded of the participation by telephone and five e-mail reminders. The e-mail had link that was uniquely designed for the participant e-mail address and could not be forwarded. This ensured non-duplication of the responds or e-mail been forwarded to people outside the target population, therefore ensuring results reliability.

4.4.5. Advantages and Disadvantages of the Research Instruments

Table 4-1: Research Instruments Limitations

RESEARCH INSTRUMENT	ADVANTAGES	DISADVANTAGES
Semi-Structured In-Depth Interviews	❖ Respondents can answer questions in as much detail as they want ❖ More valid information about the respondents' attitude, values and opinion can be obtained, particularly how people explain and contextualise the issues ❖ An informal atmosphere can encourage the respondent to be open and honest ❖ Flexibility – the interviewer can adjust questions and change direction as the interview is taking place	❖ Prone to bias ❖ Time intensive because of the time taken to conduct interviews, transcribe and analyse the results. ❖ Interviewer must be appropriately trained in interviewing techniques ❖ Not generalizable because small sample are chosen and random sampling methods are not used. ❖ Difficult to directly compare the results because each interview is unique
Internet based Survey Questionnaire	❖ Easy to administer ❖ Low cost ❖ Global reach ❖ Fast data collection and analysis ❖ No interviewer bias ❖ Follow up on nonresponse easy ❖ Respondents complete the questionnaire at own pace	❖ Loss of anonymity ❖ Complex to design and program ❖ Require more extensive pretesting to ensure proper functionality ❖ Limited to computer users ❖ Low response rates ❖ Points of clarification are not possible

4.5. Source of Data

The sources of data are the resources that information, related to a particular research field, can be acquired. There are two main sources of information secondary data and primary data. Hair et al. (2007:118) define secondary data as data that can be used for a research which was not gathered directly or purposefully for the research under consideration. For the purpose of information gathering existing data may save time, effort and expense in spite of the fact that it may have not originally been collected with the research project in mind.

4.5.1. Secondary Data

The secondary data is existing information that is publicly available and not within the public domain. The examples of information publicly available are literature that develop theoretical framework such as journals, newspaper, books, surveys etc. Furthermore, information not likely to be within the public domain is company records, reports, financial statements and past performance measurements. For this research study the sources of the secondary data are described in detail below.

4.5.1.1. SAP System Data

SAP System is a software application that is used in Eskom for maintenance management. SAP PM provides the capability of documenting and managing all maintenance activities performed within power stations. For the purpose of this research study, the system was used to obtain historic data in terms of PM compliance and Schedule completion of Camden power station.

4.5.1.2. Hyperwave System

The Hyperwave system is a software application that is used in Eskom for Document Management System. Hyperwave provides the ability of creating and storing any kind of content. In this research study, the system was used to obtain RBO implementation plan documents, reviews and reports of the power station of interest.

4.5.1.3. Primary Data

The primary data is the information that the researcher collects to achieve the research study objectives, such that new information is generated. The primary data sources that were used are semi-structured interviews and questionnaires surveys, the sources are described in detail below.

4.5.1.4. Semi-Structured Interviews

The semi-structured interviews were conducted on those who are responsible to implement, support and manage the RBO strategy implementation process at the power station. The participants were prudently selected according to the judgment of the researcher and availability of the participants. A limited sample of five people was interviewed to identify the underlying hindering factors of the highlighted focus areas in the literature and reports.

4.5.1.5. Structured Questionnaires

A survey questionnaire was used as the primary source of data. The respondents were cautiously selected from the technical people who are engineers, technologists or technicians by occupation but positioned as system engineers, managers, supervisors and planners. The survey results were used to supplement or validate the results obtained from secondary data sources and interviews. These results were to broaden the knowledge on identifying the key focus areas hindering the implementation process.

4.5.2. Linking the data to the propositions

The collection of information from multiple sources was used to ensure that the findings were true and certain (validity) by means of data triangulation. The multiple sources used for data triangulation combined the qualitative and quantitative information. The documents used included the power station review reports and historic plant performance results related to PM compliance and schedule completion.

4.5.3. Validity

The study design selected for this research study is defined as a descriptive and analytical cross-sectional study. In order to ensure validity of the research instruments employed in this study the following measures were taken:

- Data collection: data were collected during a sufficient length of time, that is 4 weeks, in order to allow sufficient time for most of the people to participate even if they were on leave, therefore minimizing both sampling and selection biases.
- The structured questionnaire was administered electronically instead of being self-administered, with uniquely design links to specified e-mail addresses to avoid duplication.
- Data were coded and cleaned prior to data analysis in order to ensure the validity of findings.

4.5.4. Reliability

In this research study the research instruments were ensured to be reliable through the following approaches:

- All respondents were asked similar questions and were provided with similar response options.
- The research questions were pre-tested to avoid misinterpretation. The researcher ensured that the questions were brief, not having double meaning and non-leading.

In this research study, the overall Cronbach's alpha coefficient for the Likert scale was 0.90 which implies that the instrument used to collect data for this study was reliable. It is important to note that a Cronbach's alpha coefficient of 0.00 indicates no reliability or consistency and a coefficient of 1.00 indicates perfect reliability or consistency according to Buys (2013:4-2). The same author notes that for a newly developed instrument, a reliability coefficient of 0.70 is acceptable (Buys 2013:4-2).

4.6. Data Analysis and Presentation

4.6.1. Quantitative Data Analysis

The survey questionnaire data capturing and cleaning was done using Microsoft Excel. The employed statistical methods in this study were descriptive.

4.6.1.1. Descriptive Analysis

In this study the responses to all the Likert scale data was organised and coded such as (1) strongly agree, (2) agree, (3) not sure, (4) disagree and (5) strongly disagree. The obtained responses were presented using frequency distributions. Furthermore, in order to describe the data measures of central tendency (Mean, median and mode) and dispersion (standard deviation and interquartile range) were calculated for the three main groups namely auxiliary, boiler and turbine. The mean values and standard deviation values of the three groups were compared. The data was assumed to be ordinal; the responses to several Likert items were summed. Assumptions were made that the data was normally distributed and could be described as interval data which implies that there were equal intervals between the Likert responses.

4.6.2. Qualitative Data Analysis

The semi-structured interviews were conducted with a guide; it was formulated from the literature and report reviews. The purpose of the interviews was to identify the underlying hindering factors of the highlighted focus areas in the survey questionnaire results. Content analysis was used to identify themes, categories and sub-categories. Informal content analysis was used to identify key themes and concepts contained in the data and formal content analysis was used for further category refining.

4.6.3. Data Presentation

The results of the obtained data from the analysis are presented in simple tables, graphs and charts drawn from Microsoft Excel. The chosen methods of data presentation have proven to be easily understandable to all. The conclusion and recommendations are also easily drawn out from this form of presentation.

4.7. Research Limitations

The challenges and limitations of this research study were of high magnitude and this affected the research methodology. The initial intention of the evaluation of the key hindering factors was to only collect qualitative data from the research population. The preferred method of collecting data was in-depth personal unstructured interviews. Due to time and availability constrains, the preferred method proved to be a demanding task. Therefore an alternative method of minimal semi-structured interviews and survey questionnaire was followed.

The pre-testing and validation of the survey questionnaire tend to be a time consuming, as the pre-selected sample was familiar with the organisation acronyms and systems. Section B and C had to be re-phrased from CMMS to the currently used system by the organisation (SAP PM).

The quantitative data was supposed to have been directly retrieved from CMMS. The lack of experience in using the system led the researcher to obtain the information from the document management system.

This research study was not identified officially as part of the population work outputs, which resulted into a potential conflict of interest. There are those who indicated their inability to participate in the research due to their work commitments.

The selected research study technique for this study was a case study technique, consequently the research findings cannot be generalised to the Eskom generation power stations. For this purpose the research findings can only be generalised for the population of the power station of interest.

4.8. Ethical Considerations

The research instrument used in this research study had introductory pages. The ethical concerns were considered as part of each introductory page. The confidentiality of the respondents was assured; respondents were promised that their identity would not be revealed. This was to eliminate the fear of consequences of participation and failure to realise the value of participation.

The data collection was done during office hours and questionnaires distributed to their work e-mails. As the research study was not officially part of the respondents work outputs, it was stipulated that the respondents are not obliged to participate or answer questions that they did not want to answer. Additionally, the respondents were assured that the responses will only be used for this particular research study purposes only. The University’s Code of Ethics for Research Guidelines covered this aspect.

4.9. Conclusion

The basis of the research design and methodology used for this research study are provided in this chapter. The techniques selected for this research study was a case study and discussed in detail. The techniques involved making use of quantitative and qualitative analysis in a structured manner. Semi-structured interviews were conducted first limited to a small sample of management. The selection criteria were based on managers that are directly involved with the implementation of the RBO strategy. Based on the outcomes of the interviews, the survey questionnaire was developed. The interviews were first conducted to identify the underlying factors hindering the implementation of the RBO strategy from the identified key focus areas.

The research methodology and research instruments are also presented, including the advantages and disadvantages of the each research instrument. The limitations of this research study are described in detail, which were very evident when collecting data. However, the ethical issues that arose during data collection were given careful attention. The Ethics Codes preceded all efforts taken for this research study to be authentic.

5. CHAPTER 5: RESULTS

5.1. Introduction

This chapter presents a summary of relevant analysis carried out on data collected in this research study. It should be noted the research design and methodology were described in the previous chapter. The results are therefore a direct input into the objectives and are displayed in the form of tables and graphs. The total sample of this research study was 47 respondents involved in the RBO strategy implementation.

To address the research questions of the problem statement identified and discussed in Chapter 1, the research instruments used in this research study were semi-structured interviews and survey questionnaire. Quantitative data was collected using close ended survey questionnaire that was distributed online to the entire research population. The qualitative data was collected using semi-structured interviews on a limited number of management employees in different departments at the power station of interest. The survey questionnaire results are presented in section 5.2.

5.2. Survey Questionnaire Results Analysis

This section addresses the analysis of results collected through the survey questionnaire responses. The researcher received a total number of 47 completed questionnaires for this research study. The total number of the population was 75 employees at the power station of interest. The population included all employees in different departments, plant areas, work experience, job levels and educational qualifications.

The survey questionnaire was divided into six sections with a total of 33 questions that were completed. The first section aimed to identify the demographic factors of the respondents, and consisted of five questions. The second section aimed at finding out the CMMS usage by respondents, and consisted of six questions. The aim of the third section was to find out the level of quality of the information retrieved from the CMMS, and consisted of five questions.

The fourth section aimed at identifying the human dynamics consideration during RBO strategy implementation, and consisted of five questions. The aim of the fifth section was to establish management contributions during RBO strategy implementation, and consisted of eight questions. The last section, section six, aimed at establishing future improvements considerations, and consisted of three questions.

The results of the questionnaires are discussed below.

5.2.1. Section A: Demographics Analysis

This section presents data pertaining to the respondents' departments, plant areas, work experiences, task grades and educational qualifications.

5.2.1.1. Departments

The distribution of departments across the sample is presented in Figure 5-1.

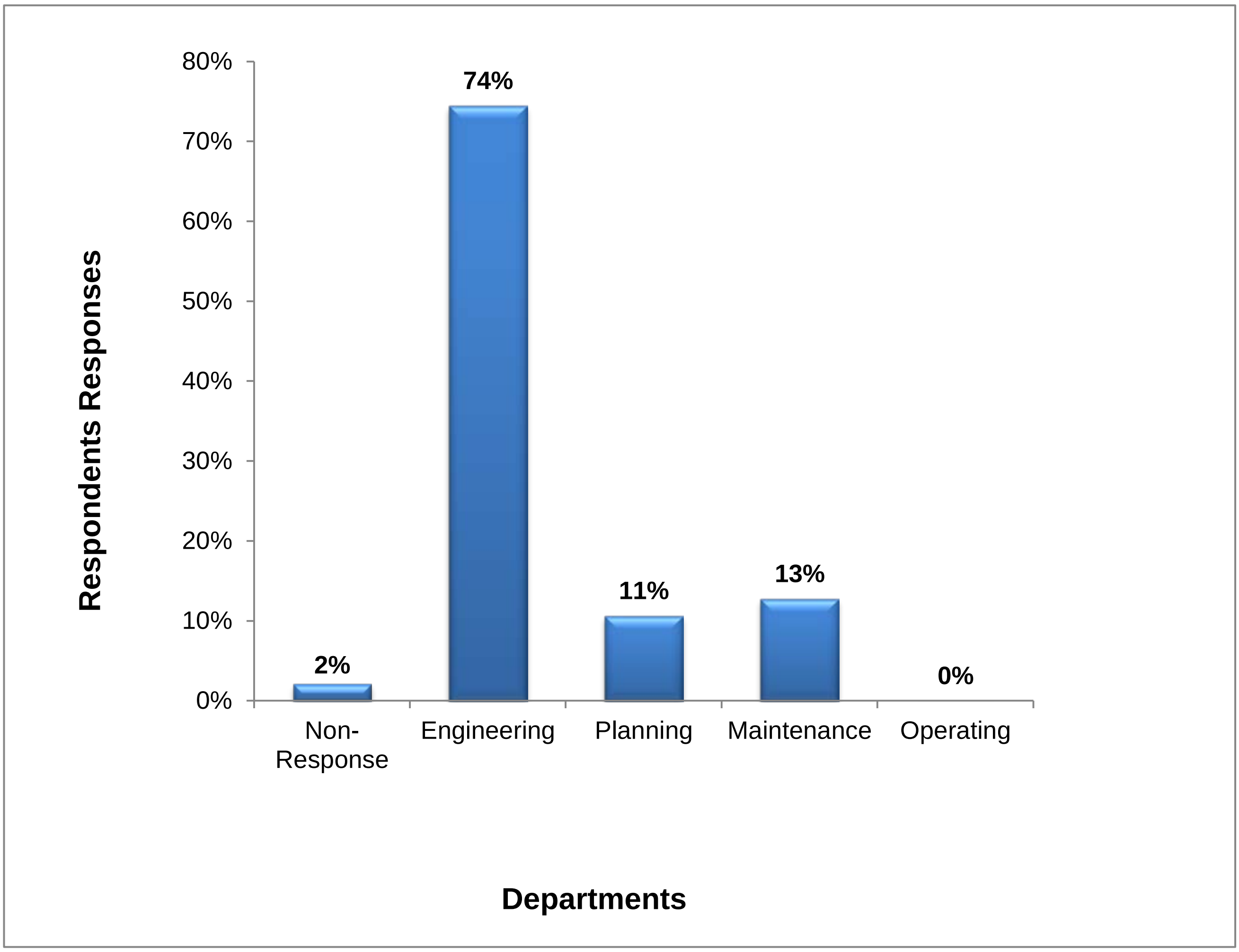

Figure 5-1: Respondents' departments

The results show that the majority of respondents were from the engineering department making up 74 percent of the respondents. None of the operating department employees participated in the research study.

5.2.1.2. Plant Areas

Figure 5-2 presents the respondents responses pertaining to the plant discipline.

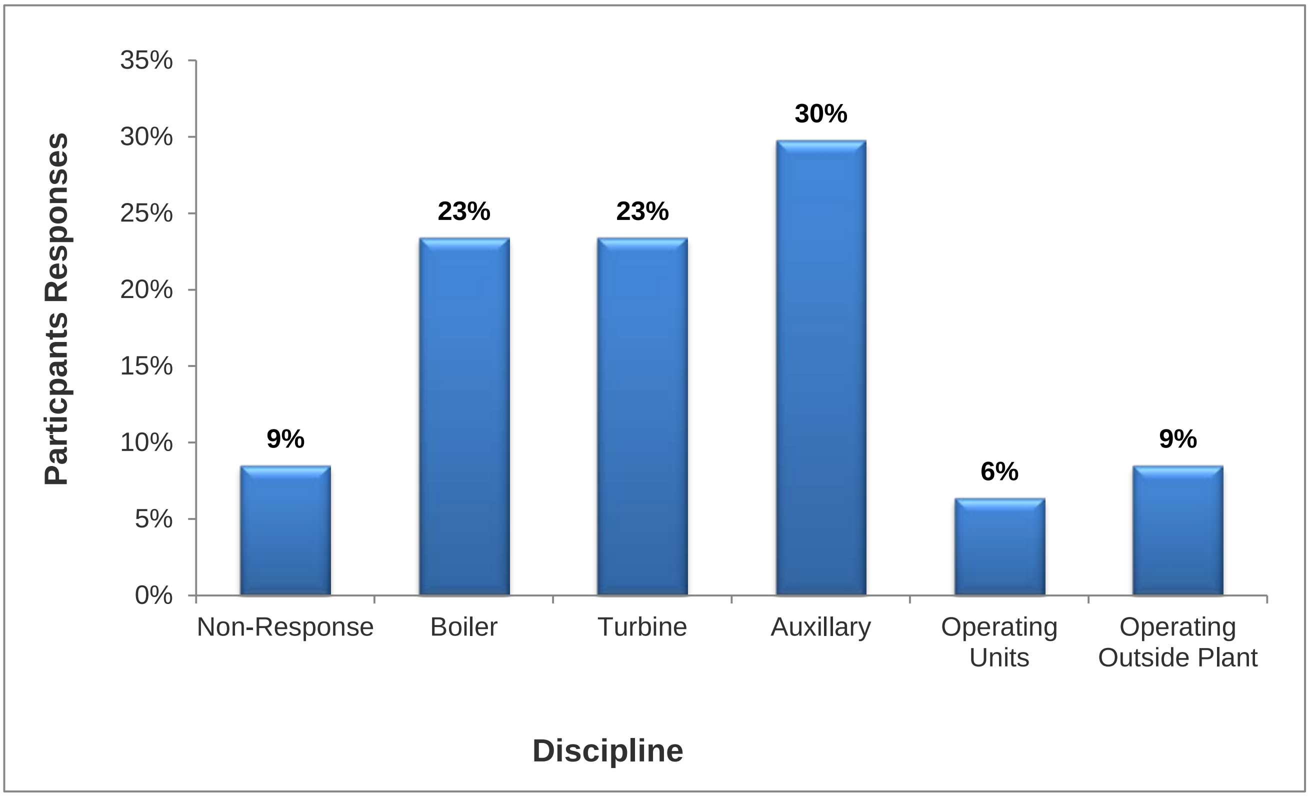

Figure 5-2: Respondents' plant discipline

The results indicate that all plant disciplines were represented. The majority of respondents were from Auxiliary, Boiler and Turbine disciplines with 30, 23 and 23 percent of the respondents respectively. The least of the respondents were from the Operating units discipline with 6 percent of the respondents.

5.2.1.3. Work experiences

The distribution of the respondents' work experience is presented in Figure 5-3.

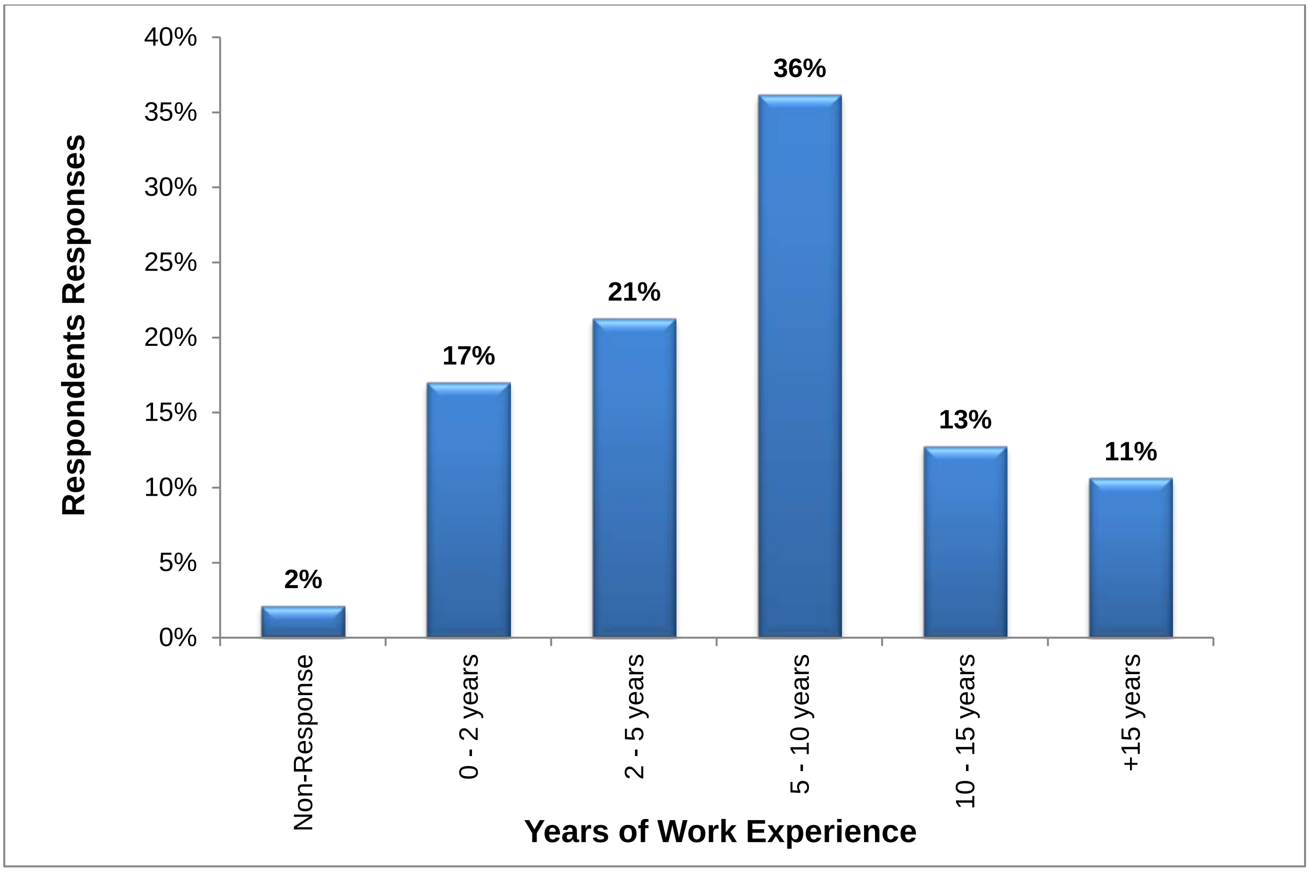

Figure 5-3: Respondents' years of experience

The results of the work experience of the respondents indicate that most respondents' working experience as 5 years to 10 years with 36 percent of the respondents. Respondents that are more experienced with work experience of over 15 years were the least with 11 percent of the respondents.

5.2.1.4. Task Grades

Figure 5-4 presents the task grades of the respondents.

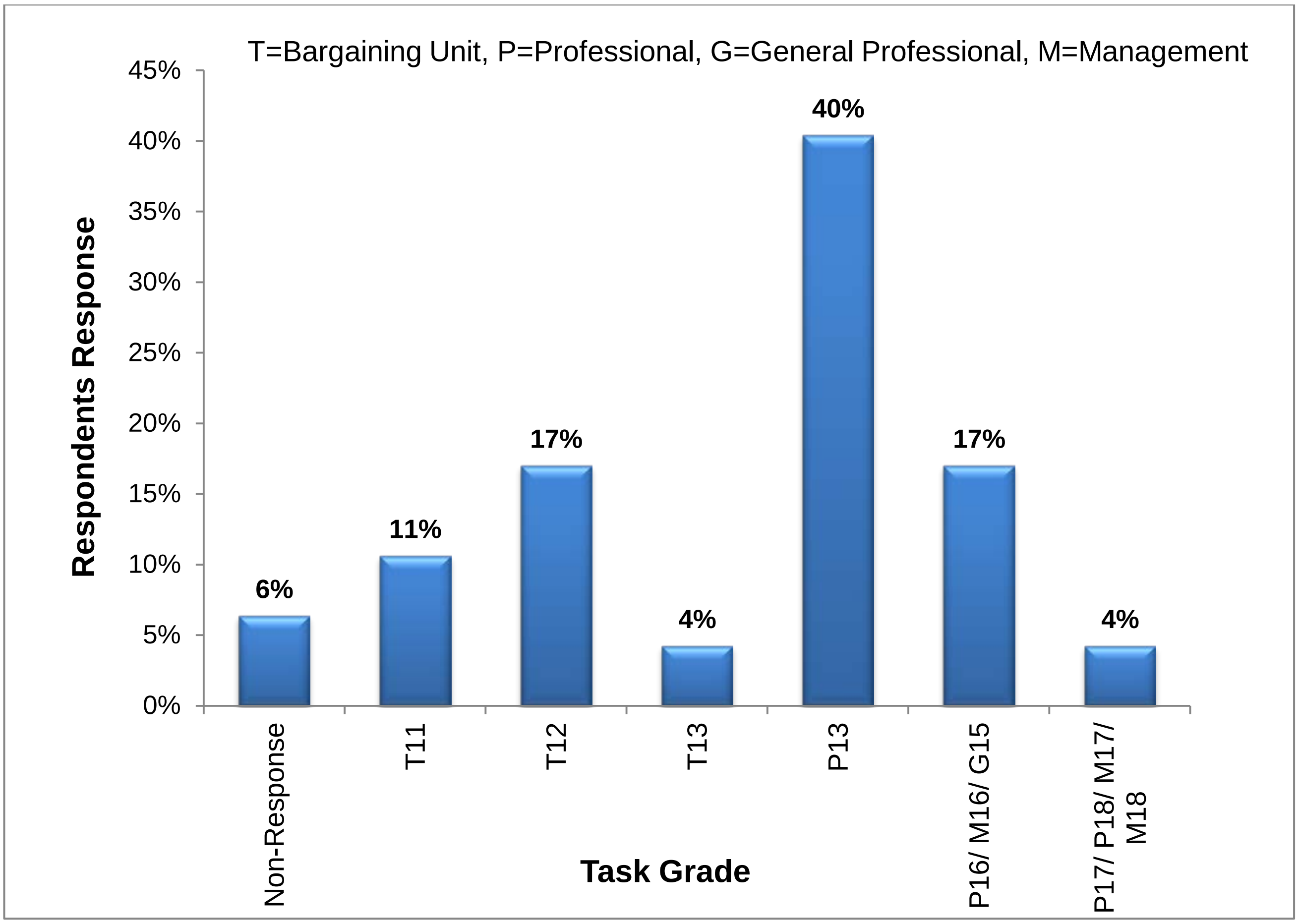

Figure 5-4: Respondents' task grade

The results presented multi-modal distribution, which indicated more than one population in the study. Most of the respondents were in the professional category whose task grade was P13, which made 40 percent of the respondents. The Bargaining Unit respondents and MPG category were both 17 percent of the respondents respectively.

5.2.1.5. Educational qualification

Figure 5-5 presents the highest levels of education attained by the respondents.

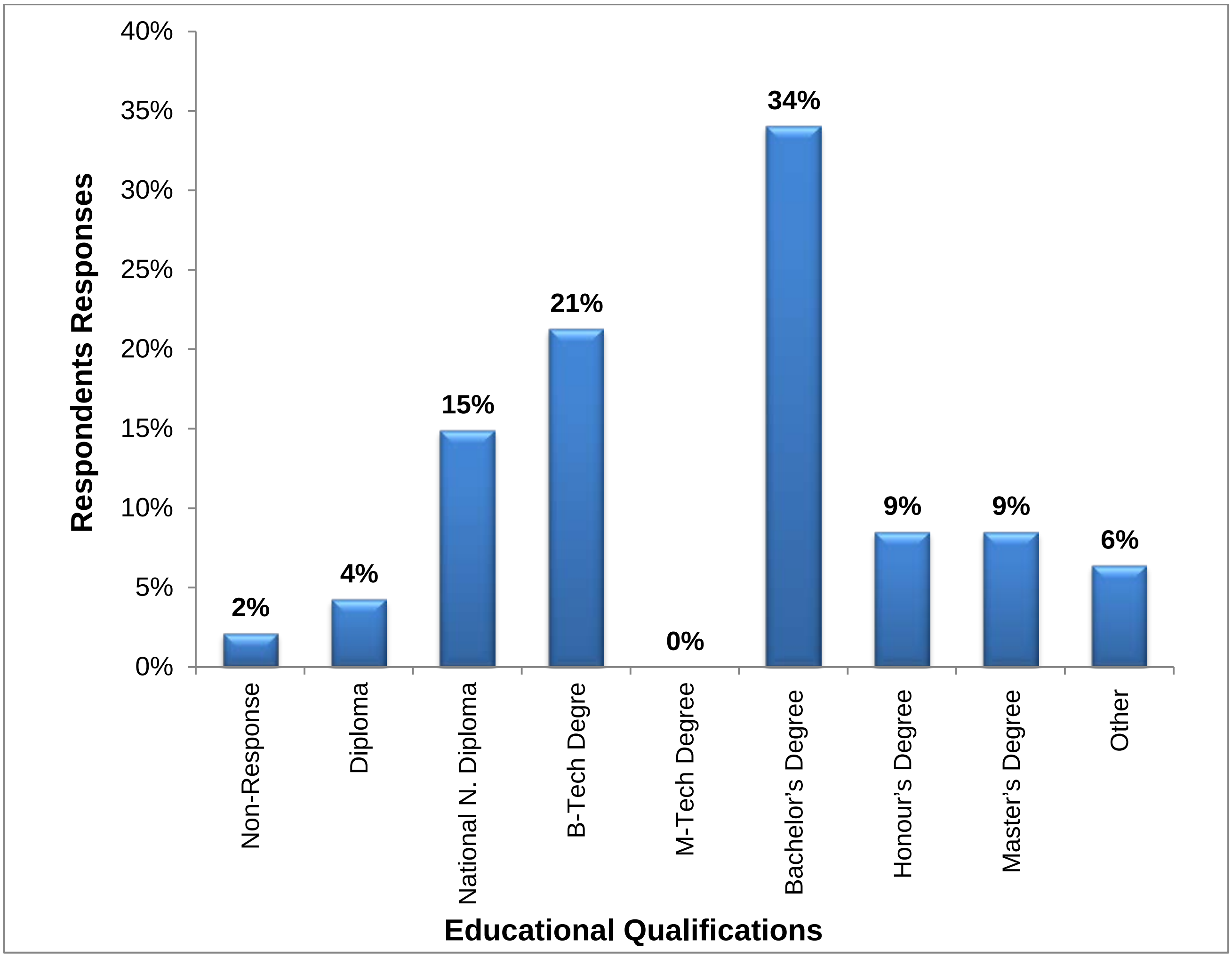

Figure 5-5: Respondents' highest level of education

The results of the respondents' highest level of education indicate the majority of the respondents were those who had Bachelor's degree, B-Tech Degree and National Diploma with 34, 21 and 15 percent of the respondents respectively. The least of the respondents were those who had Diploma with 4 percent of the respondents. None of the respondents had an M-Tech degree.

5.2.1.6. Demographics Descriptive Summary

The results indicate that the majority of respondents (74%) were from the engineering department. Most of respondents were from the auxiliary, boiler and turbine department. The respondents had working experience between 0-2 years and 5-10 years of, but the period of the assessment related to the person 'now'. Furthermore, of the 47 respondents, the majority of 19 (i.e. 40%) and 8 (i.e. 17%) had a task grade of P13 and T12, with 70 percent of the respondents having the highest level of education of a Bachelor's Degree, B-Tech Degree and National Diploma.

The following sections pertain to the research results of the respondents assessment on the questions related to the research variables mentioned in section 1.5.

5.2.2. Section B: Computerized Maintenance Management System (CMMS) Application

This section was intended to evaluate the use of CMMS by respondents. The assessment was done by asking on the respondents' knowledge and use of the CMMS. The Likert scale questions are presented collectively and other questions are discussed separately.

The research findings in respect of the question whether respondents knew the CMMS used at the organisation is shown in Figure 5-6 of this section.

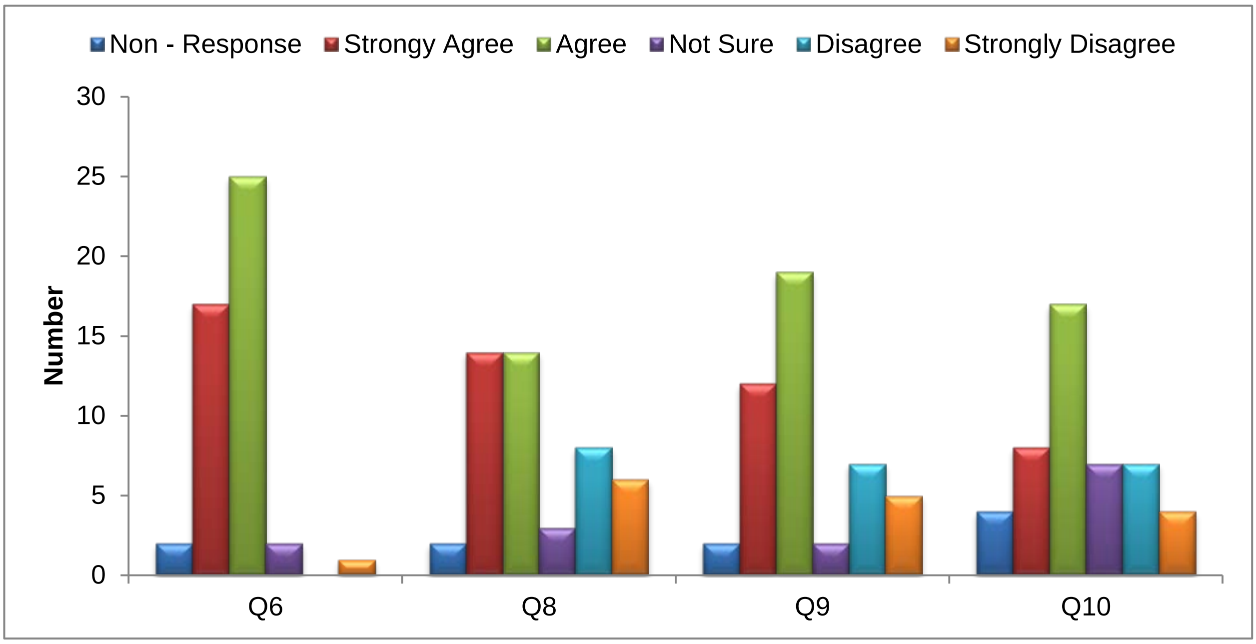

Figure 5-6: CMMS use

Q6. I know what SAP PM is.

The research results in Figure 5-6 show that 36 percent of the respondents strongly agreed to know the CMMS used in the organisation and 53 percent of the respondents agreed. Only, two percent of the respondents strongly disagreed to know the CMMS used at the organisation.

The results indicate that 89 percent of the respondents agreed to know the CMMS used in the organisation. The researcher regards this finding to be a true representation of the power station employees' knowledge of CMMS; as the system was adopted by the organisation in 2002. The majority of the respondents had a working experience of 5 – 10 years. The ever increasing organisational awareness of this system has made it difficult for engineering and maintenance functions to ignore.

Q8. I have access to SAP PM

The research findings in respect of the question whether respondents have access to the CMMS is shown in Figure 5-6.

The results show that 30 percent of the respondents strongly agreed and agreed, respectively, to have access to the CMMS. Seventeen percent of the respondents disagreed and 13 percent respondents strongly disagreed to have access to the CMMS.

The results indicate that 60 percent of the respondents agreed to have access to the CMMS. The portion of respondents who disagreed to having access to the CMMS comprise of 36 percent of novice employees that have no access to the CMMS. The result is assumed to be indicative of the sample representative as it contained a number of novice employees with 0 – 2 years working experience. As the users of the CMMS it is imperative that the access to the CMMS is attained for effectiveness.

By not having access to the CMMS the employees are not able to optimise maintenance decisions by improving maintenance costs, reducing equipment downtime as a result of scheduled preventative maintenance, increasing equipment life, storing historical records to assist in the planning and budgeting of maintenance and generating maintenance reports (O'Donoghue et al. 2004:228).

Q9. I have received training to use SAP PM to perform my duties

The research findings in respect of the question whether respondents have received training to use the CMMS to perform their duties is presented in Figure 5-6.

The results show that 26 percent of the respondents strongly agreed to have received training to use the CMMS to perform their duties and 40 percent of the respondents agreed to have received training to use the CMMS to perform their duties. Fifteen percent of the respondents disagreed and 11 percent respondents strongly disagreed to have received training to use the CMMS to perform their duties.

The results reveals that 66 percent of the respondents agreed to have received training to use the CMMS to perform their duties while only 26 percent of the respondents disagreed. The respondents that had not received training 58 percent were novice employees with 0 – 2 years working experience. Interpreting the results is that most of the respondents have been trained to use the system to perform their duties.

This is essential because employees have appropriate skills to perform their duties, motivated and effective. It helps in making informed decisions therefore resulting in optimising maintenance practises and saving money by doing the right maintenance at the right time.

Q10. The SAP PM training was adequate to perform my duties.

The research findings in respect of the question whether respondents found the CMMS training adequate to perform their duties is shown in Figure 5-6.

The results illustrate that 17 percent of the respondents strongly agreed and 36 percent of the respondents agreed that the CMMS training was adequate to perform their duties. Fifteen percent of the respondents disagreed and 9 percent respondents strongly disagreed that the CMMS training was adequate to perform their duties.

Employees who agreed that the CMMS training was adequate to perform their duties (53 percent) and 24 percent of the employees disagreed. The respondents who disagreed that the provided training was adequate to perform their duties were mainly novice professional with 0 – 2 years of working experiencing. This was expected to stand out, as management in section 5.3.4 was quoted saying "*we need… training packages that can talk to a new employee and he is able to study and understand the content; that is, what to do*." and *"it is a lot of information within a short period of time".*

This can result in frustrated employees because they do not understand how to perform their duties and are less likely to reach their optimum level of productivity. If the employees are not utilised fully the production targets and organisation goals will not be recognised.

Q7. Please indicate the SAP PM SUB Module(s) you are currently using.

Figure 5-7 shows the research findings in respect of the question to indicate sub-modules the respondents are using.

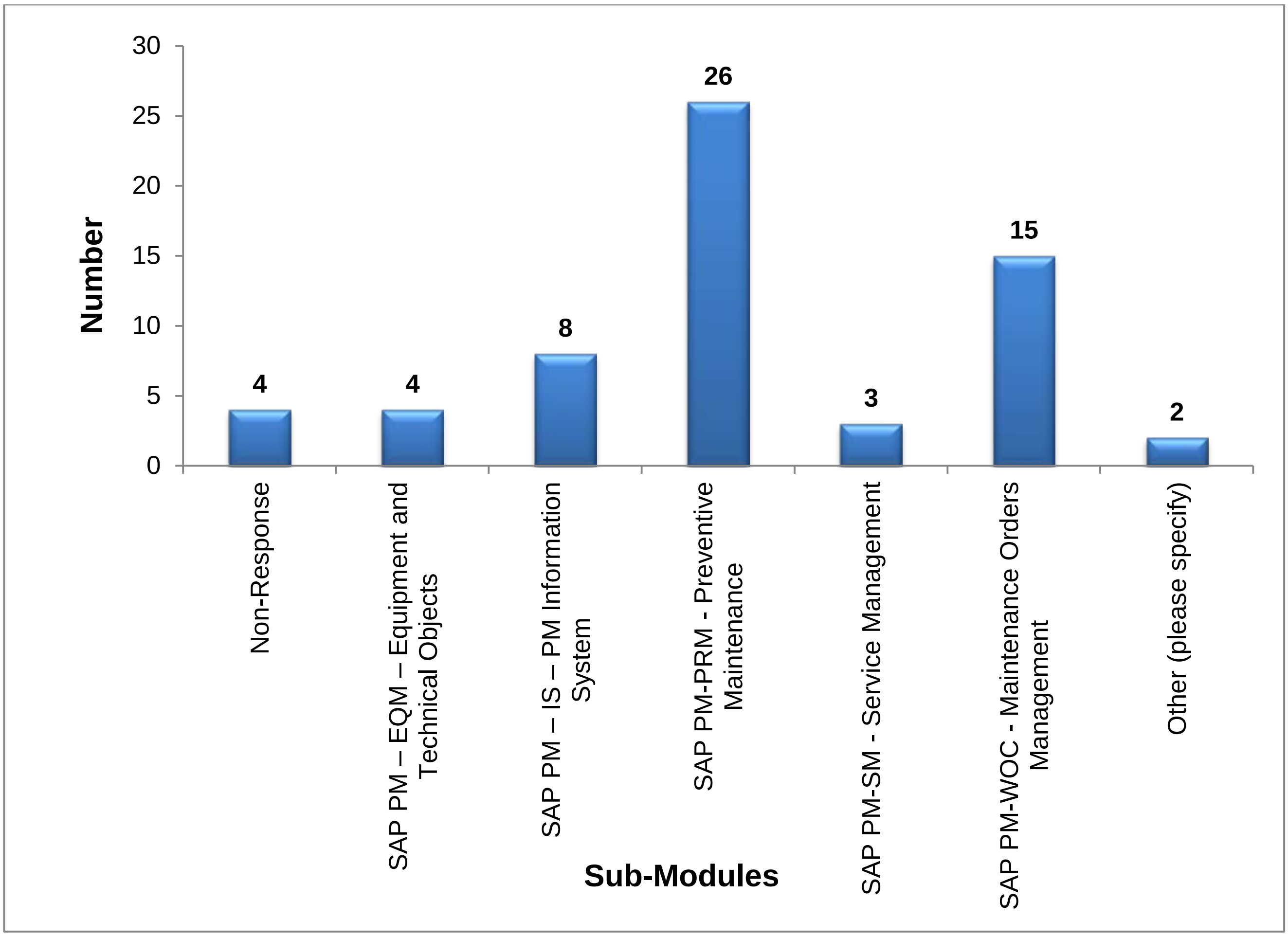

Figure 5-7: The use of CMMS Sub-Modules

The research results in Figure 5-7 show that 55 percent of the respondents use the Preventive Maintenance sub-module and 32 percent of the respondents use Maintenance Orders Management sub-model. Four percent of the respondents use service management.

In the power utilities context, work orders, reports and dispatching of maintenance crew are shown to be important aspects of CMMS use (Werner et al. 2005:781). The results indicate that there is a significant use of CMMS sub-modules enabling the management of the aforesaid aspects.

This shows that the power station of interest is using the expected CMMS sub-modules to perform their engineering and maintenance functions. The most indicated used system sub-module may also mean that routine maintenance is the primary maintenance bases. The other sub-modules of SAP such as SAP PM – SM (Service Management) was expected to be less used because most of maintenance services are outsourced. Furthermore, SAP PM - EQM (Equipment and Technical Objects) is less used because the capturing of technical objects is done centrally by Eskom SAP CoE (Centre of Excellence).

Q11. I use the SAP PM for.

The research findings in respect of the question what functions the respondents use the CMMS is shown in Figure 5-8.

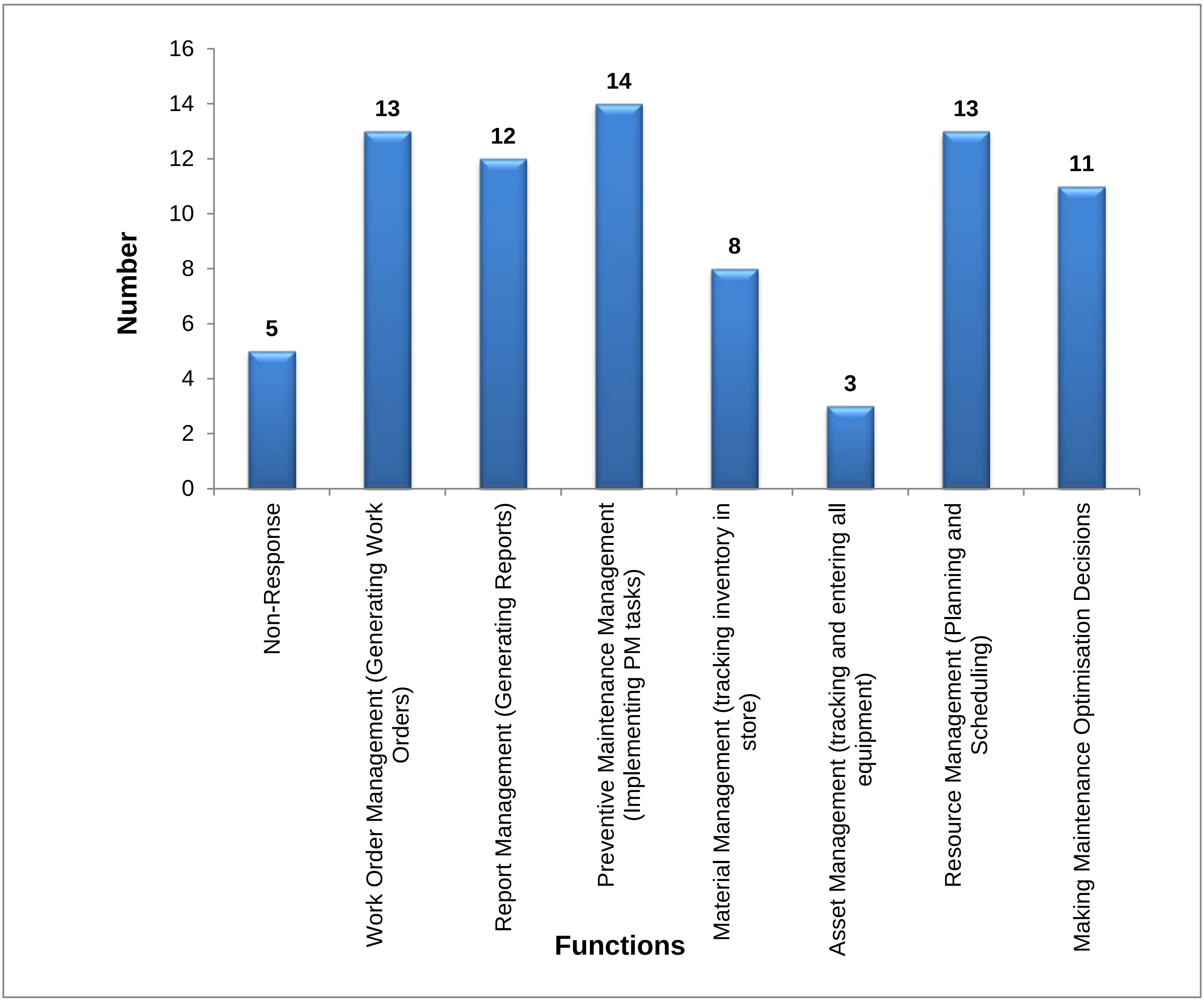

Figure 5-8: The use of CMMS functions

The research results in Figure 5-8 show that 30 percent of the respondents use the CMMS for Preventive Maintenance Management and 28 percent of the respondents use the CMMS for Works Orders Management and Resource Management respectively. Six percent of the respondents use the CMMS for Asset Management.

There is a subsequent use of the CMMS for all the fundamental functions of the CMMS in the power utilities. It quite interesting to note that 23 percent of the respondents use the CMMS for Maintenance Optimisation Decisions and that most are from engineering. As custodians of the plant and responsible for the planned and unplanned maintenance, it is indeed a positive result even though there is improvement required in all departments in this regard. Moreover, it is of interest to note that the least used function is Asset Management (tracking and entering all equipment) which is the fundamental basis of equipment maintenance. The equipment maintenance history is based on Functional Locations (FLOCs) and not equipment information. This leads to inappropriate maintenance strategies being in place for incorrect equipment. The equipment failure history is captured on FLOCs and not on the equipment serial number, resulting in incorrect failure history reported on different equipment placed on the same FLOC, affecting technical investigations and decision-making.

According Fernandez et al. (2003:965) the role of CMMS is powerful tool for obtaining information from raw data and support decision making process.

5.2.2.1. Descriptive findings summary on CMMS application

A collective view of the interpreted results and findings of the different questions show that the organisation maintains a CMMS aligned to the maintenance strategic and operational goals. This system is well known in different departments responsible for the RBO strategy implementation. The CMMS comprises of sub-modules considered important in the power utility environment. There is a significant use of the different sub-modules with preventive maintenance mostly used. It implies that for some equipment an effective preventive and condition-based maintenance programme are established. The interesting finding is that the least use CMMS function is Asset Management.

Although access to the CMMS is considered crucial for those involve in the RBO strategy implementation, there 13 respondents from engineering who do not have access. This is a great concern as engineers are responsible for compiling maintenance strategies and ensuring implementation thereof. Lack of system access can lead to equipment not properly maintained, poor decision making and lack of continuous improvement.

Moreover, the training offered for the CMMS is considered adequate by over 50 percent of the respondents; however there are 10 respondents from engineering who regard the training inadequate. It implies that the engineers will not be able to ensure that proper maintenance is implemented on their responsible equipment and optimise maintenance.

Lastly, it is worrying to realise that only 6 percent of the respondents confirmed to use the CMMS for asset management (tracking and entering equipment). More worrying is that the 3 employees are from engineering and none from planning, planners are responsible for entering equipment information in the CMMS to create Preventive Maintenances (PMs).

The CMMS information quality results are presented in section 5.2.3.

5.2.3. Section C: Computerized Maintenance Management System (CMMS) Information Quality

This section was intended to evaluate the level of information quality retrieved from the CMMS. The assessment was done by asking questions related to the information quality variables stipulated in the literature. The questions results are presented collectively in Figure 5-9.

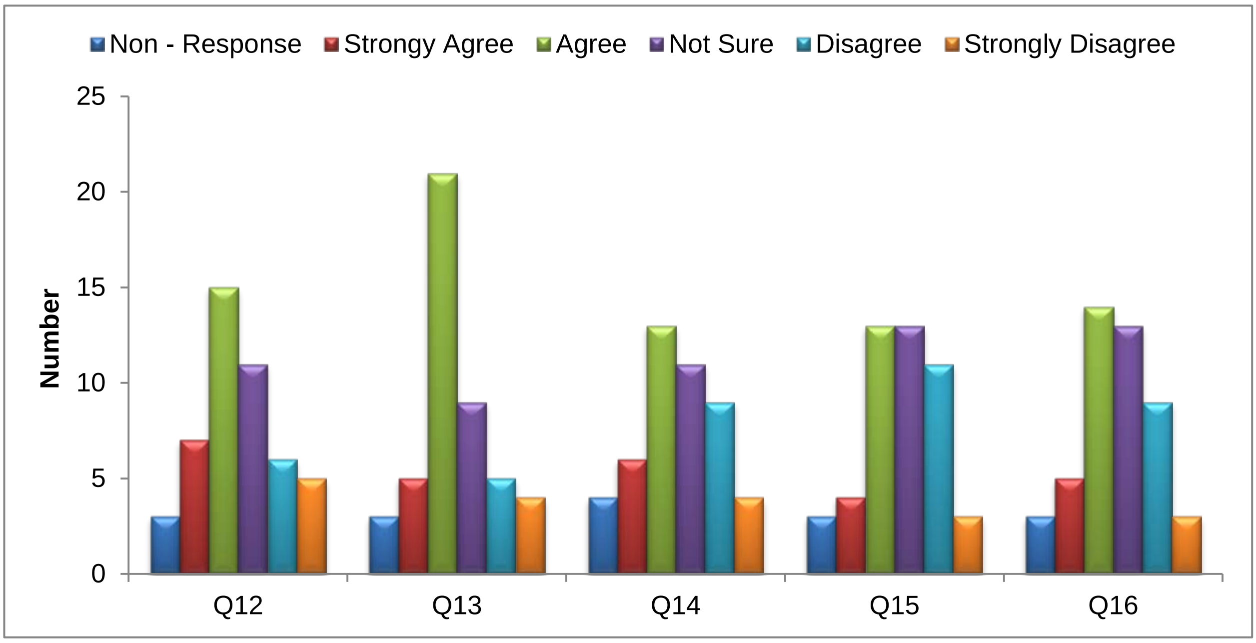

Figure 5-9: CMMS Information Quality

Q12. The information I obtain from the SAP PM is sufficiently COMPLETE i.e. I am able to obtain all information required to perform my duties.

The research findings in respect of the question whether respondents regarded the information obtained from the CMMS sufficiently complete are shown in Figure 5-9.

The research results in Figure 5-9 show that 15 percent of the respondents strongly agreed and 32 percent of the respondents agreed that the information retrieved from the CMMS is sufficiently complete. Whereas, 13 percent of the respondents disagreed and 11 percent of the respondents strongly disagreed that the information retrieved from the CMMS is sufficiently complete.

The results indicate that 47 percent of the respondents agreed that the information retrieved from the CMMS is sufficiently complete and 24 percent of the respondents disagreed. The figure above shows a worrying picture that 11 of the respondents regarded information incomplete. More worrying of the 11 respondents that indicated the information incomplete, 10 are from engineering. Engineering is responsible for compiling of maintenance strategies and outage scope of work. Maintenance strategies and outage scope of work that does not address the correct root cause failures and preventive maintenance activities, supported with historic data, causes poor plant reliability, availability and functionality.

Q13. The information stored in SAP PM is easily ACCESSIBLE i.e. I am able to access all the information to perform my duties, from the SAP PM.

Figure 5-9 presents the research findings in respect of the question whether respondents have access to the information obtained from the CMMS.

The research results show that 11 percent of the respondents strongly agreed and 45 percent of the respondents agreed that they have access to the information retrieved from the CMMS. However, 11 percent of the respondents disagreed and 9 percent of the respondents strongly that they have access to the information retrieved from the CMMS.

The results indicate that more of the respondents agreed that they have access to the information retrieved from the CMMS and only 20 percent of the respondents disagree. The 20 percent of the respondents that indicated the information inaccessible, 89 percent is from engineering. Fifty six percent of the respondents were experienced. Moreover, thirty-five percent of the respondents who agreed to have access to the information retrieved from the system had disagreed to have access to the system.

This still poses a concern of the bases of maintenance strategies and outage work scope decision making. The accessibility of information play a pivotal role in making well informed maintenance decisions. The increased availability of data makes it possible for accurate and precise decision-making in maintenance, given that the collected data are relevant, used correctly and maintain the expected level of quality (Tretten & Karim 2014:291).

Q14. The information I obtain from the SAP PM is RELEVANT i.e. I am able to use all the information stored in the SAP PM to perform my duties.

The research findings in respect of the question whether the information obtained from the CMMS is relevant is shown in Figure 5-9.

The research results show that 13 percent of the respondents strongly agreed and 28 percent of the respondents agreed that information retrieved from the CMMS is relevant. Whereas, 19 percent of the respondents disagreed and 9 percent of the respondents strongly that information retrieved from the CMMS is relevant.

Information relevancy is very important in maintenance as technical and life of plant decisions depends on the relevance of the information at hand. The results indicate that 41 percent of the respondents agreed and 28 percent of the respondents disagreed that information retrieved from the CMMS is relevant.

It is of great concern that 12 of the respondents who disagreed are from engineering. It is still of great concern of the bases of maintenance strategies and outage work scope, outage work that is not scoped correctly have severe implications on plant performance. The implication of minimal utilisation of the CMMS function (Asset Management) supports this finding, as information on the system not corresponding to the equipment on the operating units.

By considering relevant data from relevant working areas such as maintenance policy, production method and procedures, quality system, organisation, personnel competence and training level, cost-effective maintenance decisions can be achieved effectively (Al-Najjar & Kans 2006:617).

Q15. The information I obtain from SAP PM is ACCURATE i.e. I am able to obtain information confirming to the truth about the condition of my system.

Figure 5-9 show that 9 percent of the respondents strongly agreed that the information retrieved from the CMMS is accurate and 28 percent of the respondents agreed. Twenty-three percent of the respondents disagreed and 6 percent of the respondents strongly disagreed that that the information retrieved from the CMMS is accurate.

Overall, the results indicate that 37 percent of the respondents agreed that the information retrieved from the CMMS is accurate and 29 percent of the respondents disagreed. This finding is quite astonishing to note that of the 29 percent of the respondents who disagreed; 86 percent of the respondents are from engineering.

The integrity of strategic technical and maintenance decision making is questionable. The accuracy of stored information assists in fast cost-effective maintenance decision making. Data must be gathered in such a way that they reflect as much as possible the true situation in hand representing technical, organisational and economic perspectives in a holistic manner (Al-Najjar et al. 2006:623).

Q16. The information I obtain from SAP PM is sufficiently UP-TO-DATE i.e. I am able to obtain information prior or at the right time when required.

Figure 5-9 presents the research findings in respect of the question whether respondents the obtained information from the CMMS was found to be up-to-date.

The research results show that 11 percent of the respondents strongly agreed and 30 percent of the respondents agreed that the obtained information from the CMMS was found to be up-to-date. Nevertheless, 19 percent of the respondents disagreed and 6 percent of the respondents strongly disagreed.

The results indicate that more of the respondents agreed that the obtained information from the CMMS was found to be up-to-date and only 25 percent of the respondents disagreed. It is quite interesting to note that 83 percent of the respondents that disagreed are from engineering.

This still poses a huge concern of whether or not correct technical maintenance decisions are being made. In order to facilitate easy and correct decision making the right information has to be obtained in the right time.

5.2.3.1. Descriptive findings summary on CMMS Information Quality

A collective view of the interpreted results and findings of the different information quality questions indicate that the stored information in the CMMS is being used and quality thereof could be described. Twenty four percent of respondents from engineering considered the information retrieved from the system incomplete. Complete technical information is pivotal in the process of making cost-effective decisions in the maintenance environment. Incomplete technical information does not only affect maintenance, it also hinders operation and financial processes which in turn translate to the organisation productivity and profitability.

Furthermore, the accessibility of the information was considered limited. Twenty percent of the respondents that considered the information accessibility limited were from engineering. The results for accessibility were to be expected as there was an indication of respondents with no access to the CMMS. The main concern of information inaccessibility for engineering personnel is what informs the technical maintenance decisions made and how are maintenance strategies are being optimised?

Information relevancy is very important in maintenance as technical and life of plant decisions depends on the relevance of the information at hand. The results indicate that 28 percent of the respondents found the retrieved information to be irrelevant. Al-Najjar et al. (2006:623) state that decision making process and root cause tracing process are slowed down by large amount of irrelevant data. Moreover, lack of or inconsistent data lower the quality of decisions made.

The results of the accuracy of the retrieved information show that 29 percent of the respondents found the information inaccurate. In order to make an accurate cost-effective maintenance decision, accurate warning and action limits should be established properly based upon past data and statistical tools (Al-Najjar et al. 2006:625).

Lastly, 25 percent of the respondents disagreed that the information retrieved from the system was up-to-date. The impact of not having up-to-date information hinders the decision making process in that decisions will be made based on out-dated information. Continuous improvement and optimisation of maintenance practices are depended on up-to-date information to avoid incorrect maintenance at the wrong time.

Section 5.2.4 presents the respondents perception on human dynamics considerations during implementation on-site.

5.2.4. Section D: Human Dynamics Considerations during On-site Implementation

This section was intended to assess the consideration of human dynamics during on-site implementation of the RBO strategy. The assessment questions were derived from literature on human dynamics factors considered in strategy implementation. Figure 5-10 represents collective results for this section.

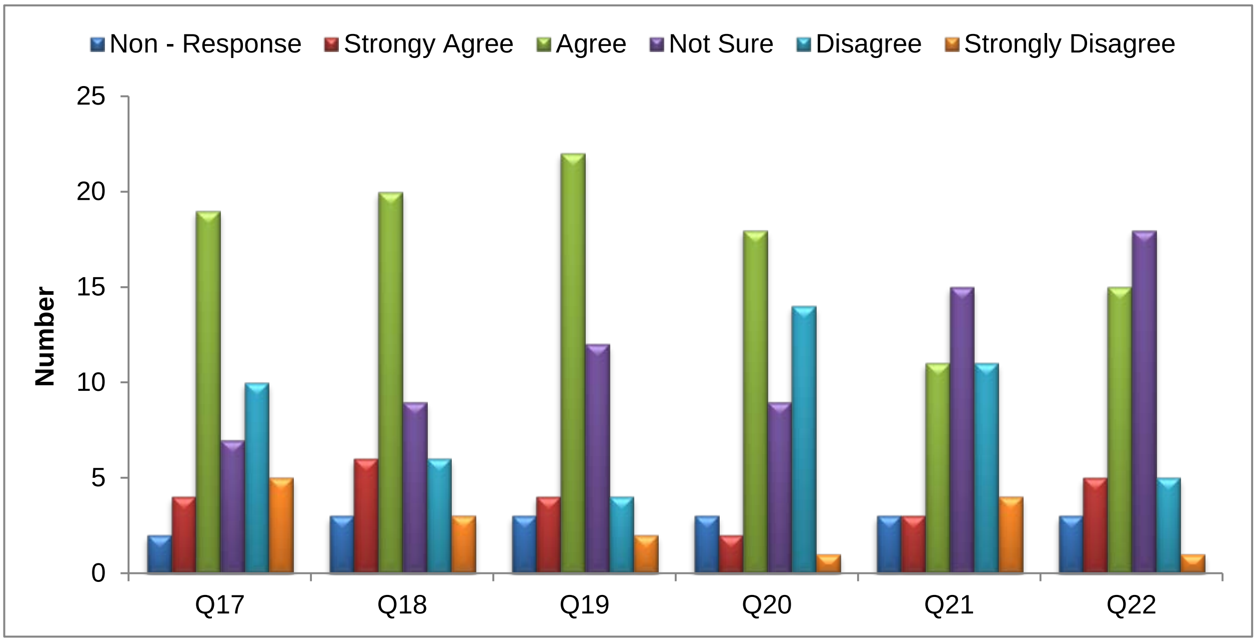

Figure 5-10: Human Dynamics Consideration

Q17. I knew about the RBO strategy before on-site implementation.

The study results show that 9 percent of the respondents strongly agreed and 40 percent of the respondents agreed that they knew the RBO strategy before on-site implementation. However, 11 percent of the respondents disagreed and 21 percent of the respondents strongly disagreed.

The collective results indicate that 49 percent of the respondents agreed to know the RBO strategy before on-site implementation and 32 percent of the respondents disagreed. A considerable portion of respondents did not know the strategy before implementation. Thirty two percent of the respondents that disagreed, 93 percent of the respondents are from engineering novice employees with a working experience of 0 – 2 years. This observation proves to be true as the RBO strategy was implemented in the early 2000s and respondents with such working experience were not employed. According to section 3.5.3 of the RBO strategy site implementation continuous training and support from the Corporate RBO consultant was to be provided.

Sterling (2003:30) emphasises that insufficient buy-in to or understanding of the strategy among implementers is one of the causes to strategy implementation failures. It is therefore of outmost importance that all levels people have to be involved from the inception of the strategy and kept informed until implementation, in order for people to buy-in into the strategy.

Q18. The RBO strategy requirements were timeously communicated before site implementation.

Figure 5-10 show that 13 percent of the respondents strongly agreed and 43 percent of the respondents agreed that the strategy requirements were timeously communicated before on-site implementation. Nonetheless, 13 percent of the respondents disagreed and 6 percent of the respondents strongly disagreed.

The combined study results indicate that 56 percent of the respondents agreed and 19 percent of the respondents disagreed that the strategy requirements were timeously communicated. Of the 19 percent of respondents that disagreed, all are from the engineering department most with 5-10 years of working experience. It is interesting to note that even though the Reliability Basis Site Implementation preparation phase in section 3.5.1 was held, the main focus of the phase was for management buy-in. There was lack of an awareness phase thereafter for the affect employees in the implementation of the RBO strategy.

Effective communication of the strategy and underlying rationale are also critically important – particularly when reaching out beyond the group directly involved in the development of the strategic plan (Sterling 2003:30-31).

Q19. Currently the RBO strategy improvements are timeously communicated before on-site implementation.

The results indicate that 9 percent of the respondents strongly agreed and 47 percent of the respondents agreed that the strategy improvements are timeously communicated before on-site implementation. Even so, 9 percent of the respondents disagreed and 4 percent of the respondents strongly disagreed that the strategy improvements are timeously communicated before on-site implementation.

The study results indicate that 56 percent of the respondents agreed and 13 percent of the respondents disagreed that the strategy requirements were timeously communicated before on-site implementation. Even though the portion of respondents that disagreed is significantly minimal there is still great concern of employees not well informed of strategy improvements. The majority of respondents that disagree have work experience of 0 – 5 years indicating that there is no accountability of ensuring involvement in the strategy implementation.

Morgan and Zeffan (2003:69) quote that when employees have a perception of low decision-making participation, being uniformed, lack of communication and poor follow-up are also situational factors that increase cynicism (Reicher et al. 1997).

Q20. The communication and interaction between different departments is consistently communicated i.e. I am able to know the progress of other departments regarding RBO strategy on-site implementation through internal communication.

Figure 5-10 demonstrates that 4 percent of the respondents strongly agreed and 38 percent of the respondents agreed that the communication and interaction between different departments is consistently communicated. However, 30 percent of the respondents disagreed that the communication and interaction between different departments is consistently communicated and 2 percent of the respondents strongly disagreed.

The collective study results indicate that 42 percent of the respondents agreed and 32 percent of the respondents disagreed that the communication and interaction between different departments is consistently communicated. The RBO strategy aims to integrate the engineering, maintenance and operation functions. It is of great concern that departments are still working in silos. In section 5.3.1 management also viewed the sentiment by stating the following:

"*From the Maintenance side, the employees do not believe in the strategies, because of… of… (Stammering) that gap I've just mentioned. The Engineer will develop the strategy on her own and then, she will expect Maintenance to implement somethings that are not level or whatever it is and all that, so, because of that RBO for them is not real something that is working or all that…"*

The effect of insufficient internal communication is lack of employee commitment and low levels of motivation and morale. Kitchen et al. (2002:52) state internal communication as a key issue with regards to the success of change management programme implementation.

Q21. With the RBO strategy successfully implemented on-site, I perceive NO risk of increased workload.

The results show that 6 percent of the respondents strongly agreed that they perceive no risk of increased workload and 23 percent of the respondents agreed. Twenty three percent of the respondents disagreed and 9 percent of the respondents strongly disagreed.

The collective study results indicate that 29 percent of the respondents agreed and 32 percent of the respondents disagreed that they perceive no risk of increased workload. However, there were a considerable 32 percent of respondents that were uncertain of the risk of increased work. This could be that the question was not fully understood or the RBO strategy implementation requirements were not understood.

There is a clear indication that most of the respondents perceive the risk of increased workload. When people perceive risk due to change they tend to resist the change or the new way of doing things. Aladwani (2001:269) state that perceived risk and habit are fundamental sources of resistance to innovations.

Q22. With the RBO strategy successfully implemented on-site, I perceive NO risk of job loss.

The study results in Figure 5-10 show that 11 percent of the respondents strongly agreed and 32 percent of the respondents agreed that they perceived no risk of job loss. Eleven percent of the respondents disagreed and 2 percent of the respondents strongly disagreed.

The collective study results show that 43 percent of the respondents agreed and 13 percent of the respondents disagreed that they perceive no risk of job loss. Similarly, there were 38 percent of respondents that were uncertain of the risk of job loss. This could be that the question was not fully understood or the RBO strategy implementation requirements were not understood. All the respondents that disagree were professionals from the engineering department.

This observation does raise concerns. The engineering professionals who are expected to be custodians of the RBO strategy implementation are under the perception that there is risk of job loss. This perception is going to result to the employees resisting the RBO strategy for the sake of maintaining their jobs and defeat the objective of the RBO strategy to improve equipment reliability.

5.2.4.1. Descriptive findings summary on human dynamics considerations during on-site implementation

A collective view of the interpreted results and findings of the different questions indicate that before implementation people were made aware of the RBO strategy and its requirements. The respondents that had working experience of 0 – 2 years were not aware of the RBO strategy before on-site implementation. Even though, the RBO strategy requirements were timeously communicated to station management, some of the respondents were not aware of the RBO strategy requirements.

The communication and interaction of different departments seem to be recognised by other respondents and not all. The strategy is perceived to have a risk of increased workload for most of the respondents. A considerable percentage of respondents were uncertain of the risk of increased workload. However, the implementation of the RBO strategy was also not perceived to have a risk of job loss. The human dynamics aspects such as communication, training and resistance were considered. There is still a considerable portion of respondents that disagreed to recognise human dynamics aspects in the implementation process. Management involvement in the implementation process is presented in section 5.2.5.

5.2.5. Section E: Management contributions during on-site Implementation

This section was intended to assess the management involvement during on-site implementation of the strategy. The assessment questions were derived from literature on management contribution importance during strategy implementation. The collective results for the assessment questions are presented in Figure 5-11.

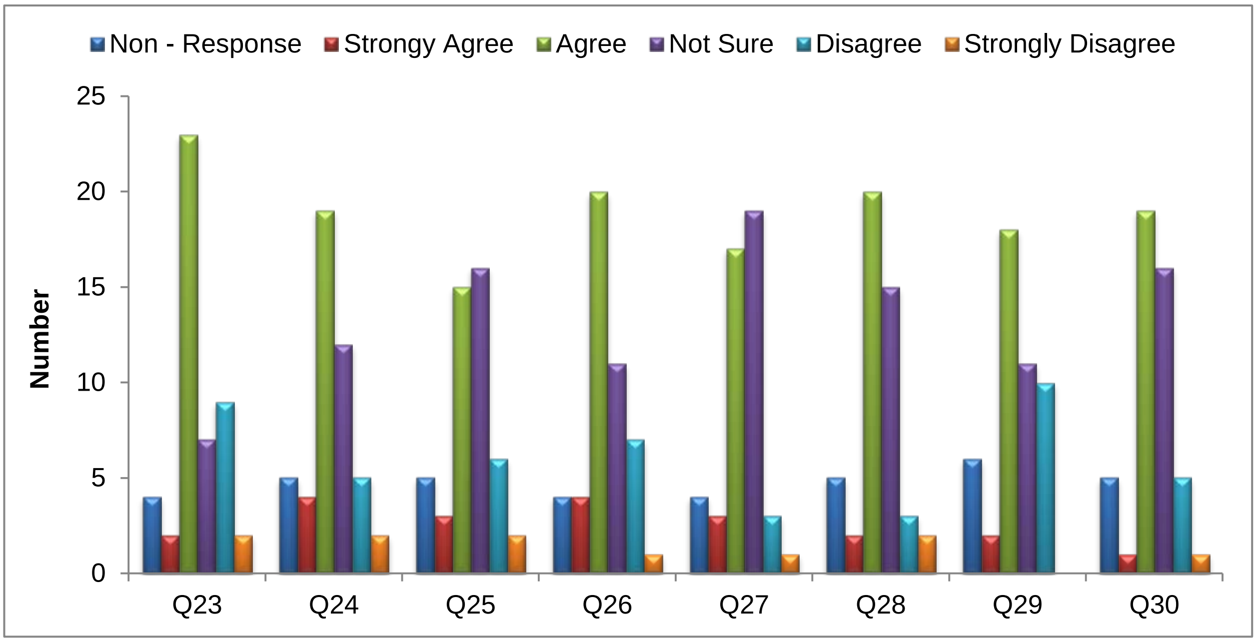

Figure 5-11: Management Contribution

Q23. Management gives attention to adequate training of SAP PM.

The collated research results show that 4 percent of the respondents strongly agreed and 49 percent of the respondents agreed that management gives attention to adequate training. Nineteen percent and four percent of the respondents disagreed and strongly disagreed respectively.

The research study results show that 53 percent of the respondents agreed and 23 percent of the respondents disagreed that management gives attention to adequate training of the system. All respondents that disagreed are from engineering, sixty four percent of the respondents had 0 – 5 years of working experience. This shows that though management is willing to invest and equip resources for proper use of the system, it is evident that novice engineering employees are not being trained on the system. This view was supported by management in section 5.3.4 in the following statement: *"we need… training packages that can talk to a new employee and he is able to study and understand the content; that is, what to do."*

It is of outmost importance that the user understands what the system is communicating and how to respond to the system (Tretten et al. 2014:293).

Q24. Management gives attention to time required to learn.

Figure 5-11 show that nine percent of the respondents strongly agreed and 40 percent of the respondents agreed that management gave attention to time required to learn. Eleven percent disagreed and four percent of the respondents strongly disagreed.

Forty-nine percent of the respondents agreed and 15 percent of the respondents disagreed that management gave attention to time required to learn. All respondents that disagreed are from engineering, 86 percent of the respondents had 0 – 5 years of working experience. This implies that even though management ensure proper understanding of the requirements for successfully implementation of the RBO strategy, novice engineering employees are frustrated with the time given to learn. In section 5.3.4 management further stated the following quotes in support of the results findings:

"It is a lot of information within a short period of time".

"The pass mark is too high; given the time allocated to the training. I am happy with the content, though".

Brenes, Mena & Molina (2008:592) state that managers and personnel poor understanding leads to poor effectiveness in implementing strategy.

Q25. Management gives attention to bottom – up communication

The collective research results in Figure 5-11 show that six percent of the respondents strongly agreed and 32 percent of the respondents agreed that management gives attention to bottom – up communication. Thirteen percent and four percent of the respondents disagreed and strongly disagreed respectively.

The research results indicate that 38 percent of respondents agreed and seventeen percent of respondents disagreed that management gives attention to bottom – up communication. The respondents that disagreed are all from engineering and 63 percent of the respondents had 0 – 5 years of work experience.

This implies that although management allows communication from the lowest level of the hierarchy to the top, novice employees find it difficult to participate in such communication way due to lack of knowledge, skills and experience in the subject matter resulting to low self-confidence.

Q26. Management has been immensely involved with the on-site strategy implementation.

Figure 5-11 show that nine percent of the respondents strongly agreed and 43 percent of the respondents agreed that management has been immensely involved with on-site strategy implementation. Fifteen percent of the respondents disagreed and two percent of the respondents strongly disagreed.

The research results indicate that 51 percent of the respondents agreed and 17 percent of the respondents disagreed. The results indicate that the respondents that disagreed are from engineering, 63 percent of the respondents had 0 – 5 years of working experience.

This implies that even though management has been involved with the on-site strategy implementation, the novice engineering employees are not seeing the involvement due to lack of knowledge of management role and responsibility in the implementation.

For strategic actors to succeed in their roles, they must first become conscious of their role. Therefore, managers need to encourage different actors to consider their role in strategy implementation (Aaltonen et al. 2002:417).

Q27. Management has been willing to provide resources for the strategy implementation.

The results indicate that 6 percent of the respondents strongly agreed and 36 percent of the respondents agreed that management has been willing to provide resources for the strategy implementation. Six percent of the respondents disagreed and two percent of the respondents strongly disagreed.

The research collective results show that 42 percent of the respondents agreed and 8 percent of the respondents disagreed. The respondents that disagreed are novice engineering employees with 0 – 5 years of working experience. The managers' key qualities that employees evaluate in any situation are integrity, competence, consistency/fairness and openness in order to gain trust.

This implies that novice employees as not being involved in the RBO strategy implementation have little trust in management to empower them. Management supported this finding in section 5.3.3 with the following quote:

“Remember, when the project was implemented, we were told that we need to release people from their normal duties, and here in this power station we do not have enough resources to even afford us freedom to do that…”

Mutual trust is consistently presented as an essential feature of change and best achieved through consultation, participation and empowerment (Morgan et al. 2003:58).

Q28. Management has been willing to make tough decisions during the on-site RBO strategy implementation.

Figure 5-11 show that 4 percent of the respondents strongly agreed and 43 percent of the respondents agreed that management has been will to make tough decisions during the on-site RBO strategy implementation. Six percent of the respondents disagreed and four percent of the respondents strongly disagreed.

The research results indicate that 47 percent of the respondents agreed and 10 percent of the respondents disagreed. The respondents that disagreed are from engineering, 80 percent of the respondents had 0 – 5 years of working experience.

This shows that management prioritised plant operations over strategy implementation in the eyes of novice engineering employees. This however clouded the understanding of their role and responsibilities in the implementation of the strategy.

Q29. Management has been consistent in communication during the on-site RBO strategy implementation.

The results show that four percent of the respondents strongly agreed and 38 percent of the respondents agreed that management has been consistent in communication during on-site strategy implementation. Twenty-one percent of the respondents disagreed.

The collated research results indicate that 42 percent of the respondents agreed and 21 percent of the respondents disagreed. More respondents agreed that managers consistently communicated new developments during strategy implementation. This demonstrates management commitment and supports to the RBO strategy implementers and will for successful implementation of the strategy. This may increase the morale of the implementers.

The implication of managers not consistently communicating new developments to the implementers promotes lack of motivation, commitment and disgruntled employees. When a trusting environment is lacking, people concentrate more on their suppositions and fears, which creates much noise. In contrast, when trust exists, people ask for help, speak openly and honestly, take risks, accept new challenges and conduct their activities with less anxiety and stress (de Carvalho 2014: 41-42).

Q30. Management has been holding regular progress reviews since the inception of the on-site RBO strategy implementation.

Figure 5-11 show that two percent of the respondents strongly agreed and 40 percent of the respondents agreed that management holds regular progress reviews. Furthermore, 11 percent of the respondents disagreed and two percent of the respondents strongly disagreed.

The research results indicate that 42 percent of the respondents agreed and 13 percent of the respondents disagreed. The results indicate that the respondents that disagreed are from engineering, 86 percent of the respondents had 0 – 5 years of working experience. This implies that even though management held regular progress reviews, the novice engineering employees are not part of the progress reviews.

The implication of employees not being involved in progress reviews restricts them in making meaningful contribution to the decision process. Amah & Ahiauza (2013:671) state that the increase in level of employee involvement empowers employees to tend to have power over decision, process and outcomes.

5.2.5.1. Descriptive findings summary on management contributions during on-site implementation

A collective view of the interpreted results and findings of the different questions on management contributions during RBO strategy implementation indicate that adequate training was given attention by management. Furthermore, the results also indicated that novice employees have not attended training. The required time to learn seem to be ensured by management, however the novice employees that had being to the training brought the notion of frustration to the time allocated for training.

However, communication barriers in the bottom-up communication strategy came out strong from novice employees. Additionally, management involvement during strategy implementation was not well translated to novice employees due to misunderstood roles and responsibilities. Most of the novice employees indicated being isolated during strategy implementation as they did not form part of the implementation team.

Likewise, management was not seen to encourage strategy implementation over day to day plant operations by novice employees. The communication of new developments and regular progress reviews during strategy implementation seem to be one of the concern areas for the novice employees. The management contributions aspects considered in this study seem to have been considered, though there is still a considerable portion of respondents that do not recognise them in the implementation process.

The respondents human dynamics aspects considered in this study seem to have been considered, though there is still a considerable portion of respondents that do not recognise them in the implementation process. It is quite interesting to note that there was a high ‘unsure’ response in most of the questions. The evaluation of the deployed strategy implementation process and tools for future improvements is presented in section 5.2.5 .

5.2.6. Section F: Future Improvement(s) of Similar Strategies in a Power Generation Environment.

This section was intended to assess the future improvement(s) of similar strategies in a power generation environment. Figure 5-12 presents the collective results for the assessment questions.

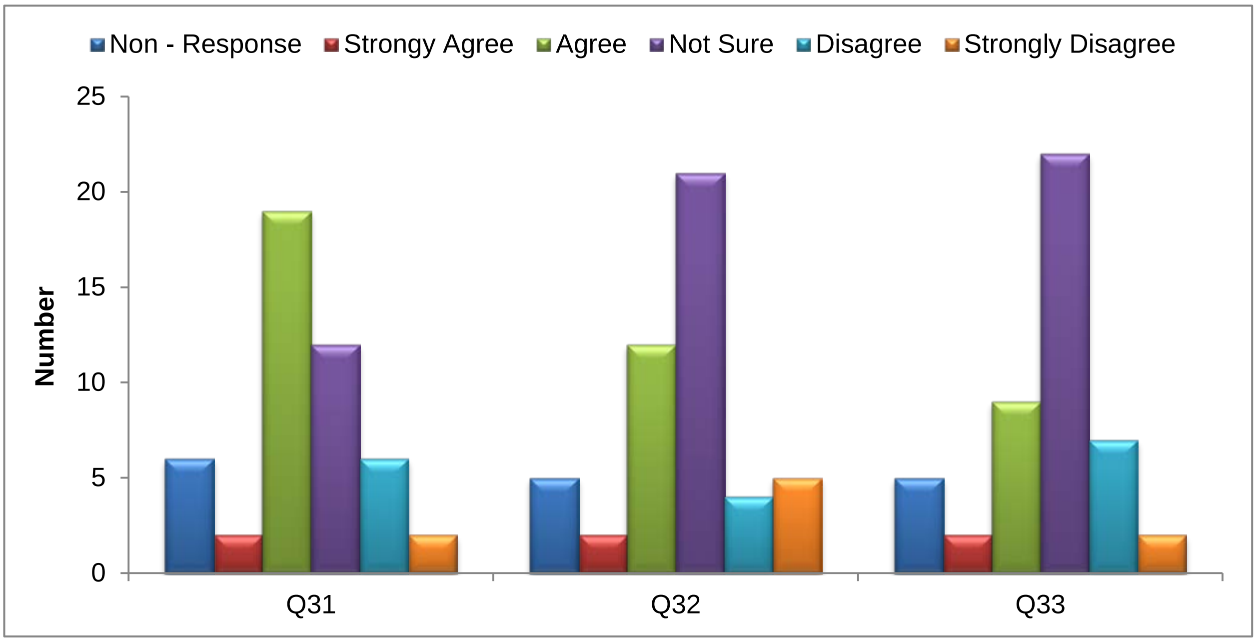

Figure 5-12: Future Improvement(s) of Similar Strategies

Q31. The communication tool(s) used in this initiative were the most appropriate to deal with strategy implementation.

Figure 5-12 show that four percent of the respondents strongly agreed and 40 percent of the respondents agreed that communication tool(s) used for the RBO initiative were most appropriate to deal with strategy implementation. Furthermore, 13 percent of the respondents disagreed and four percent of the respondents strongly disagreed.

The research results indicate that 44 percent of the respondents agreed and 17 percent of the respondents disagreed. The results indicate that the respondents that disagreed are from engineering, 75 percent of the respondents had 0 – 5 years of working experience.

This implies that the communication tools were used in the initial stages of the RBO strategy implementation, as the novice engineering employees did not applaud the tools.

Q32. The SAP PM training program used, during RBO strategy implementation, is the most effective training program for new technology end-users during strategy implementation.

The results indicate that 4 percent of the respondents strongly agreed and 26 percent of the respondents agreed that the CMMS training program used is the most effective training program for implementation of new-technology initiatives. However, nine percent of the respondents disagreed and 6 percent of the respondents strongly disagreed.

The collective results show that 30 percent of the respondents agreed and 15 percent of the respondents disagreed that the CMMS training program used is the most effective training program for implementation of new-technology initiatives. It is interesting to note that 45 percent of the respondents were not sure of the effectiveness of the CMMS training program for RBO strategy implementation. The 76 percent of respondents that were not sure had 0 -5 years' work experience and 5 – 10 years' work experience respectively. Moreover, 44 percent of the respondents had received CMMS training to perform their duties.

This implies that novice employees and those that attended training may have not understood the content of the training to translate to effectiveness.

Training offers a good opportunity to help users adjust to the change that has been introduced by the ERP system, and helps build positive attitudes toward the system. Further, training provides hands-on experience for the users: they appreciate the quality attributes of the system and its potential benefits (Aladwani 2001: 271-272).

Q33. The management style used, for RBO strategy implementation, is the most effective management style for strategy implementation.

The results in Figure 5-12 show that four percent of the respondents have strongly agreed and 19 percent of the respondents agreed that the management style used for RBO strategy implementation is the most effective management style for the strategy implementation. Fifteen percent of the respondents disagreed and four percent of the respondents have strongly disagreed.

The result indicates that 23 percent of the respondents have agreed and 19 percent of the respondents have disagreed. Moreover, 47 percent of the respondents were not sure of the management style used is most effective management style for strategy implementation. Forty percent of the respondents that were not sure had 0 – 5 years' work experience.

The qualitative data results collected using semi-structured interviews are presented in section 5.3.

5.3. Qualitative Results Overview

This section addresses the narrative data collected through the interviews held with the management of the power station. The field notes were reviewed and the audiotapes listened to; transcribed, read and re-read. In order to familiarise self with the data and to get global impression of the interviews the verbatim transcripts were read and re-read.

After that, each verbatim transcript was worked on sequentially according to the order of data collection; each transcript was analysed one by one to the end; that is, until all data had been analysed. All similar ideas or topics were grouped together into categories and sub-categories emerged; later the themes were derived from the data.

Content analysis was carried out in this research study. The key issues were noted and codes were developed into categories and subcategories, which eventually lead to themes as advocated by Moule and Goodman (2009:349). ***Open coding*** was applied by breaking down data into distinct parts on examining the data closely and comparing similarities and differences about the phenomenon under study. The ***axial coding*** followed whereby connections between the categories and the sub-categories were made to put back the data together in order to explain the participants' views.

The following themes and categories emerged:

- 5 themes
- 12 categories
- 11 sub-categories

Themes	**Categories**	**Sub-categories**
1. Communication	• Project sensitization • Team collaboration • Team involvement	➢ Project planning ➢ Change ➢ Finances ➢ Quality compromise ➢ Buy-in and support

2. Time management	• Time for the project implementation • Training time	➢ Inadequate support
3. Staffing	• Under staffing • Work load increase	➢ SAP capturing ➢ Inaccessibility of SAP system ➢ Turnover/ resignation.
4. Training	• Selection criteria • Non-trained managers • New staff orientation	
5. Process deficiencies	• SAP • GGSC	➢ Outage related works ➢ Incomplete listing

These themes and categories are shown at the beginning of each section. They are discussed individually. The verbatim quotations from the subjects are cited; without attempts to correct, even the grammatical errors that may be there.

5.3.1. Communication

Almost all the managers, except one from the Engineering department, in the three interviews show that the RBO strategy was not communicated in time and it was poorly planned. As such, it has not been implemented effectively, as illustrated verbatim below:

"Communication was clearly offered"

"I am not sure of the communication for RBO, if it was done".

From the statements above, the findings show that generally the RBO strategy has been negatively received by station management. The reasons cited by these managers are that they were not involved in the RBO strategy planning as purported by this participant:

''Yes, the communication; why I'm supposed to do certain things, will provide a better understanding about the requisites. Maybe if we did have that understanding we would have accelerated the process, not delayed it. We also need to ensure that we have skill and resources for such strategies".

"From the Maintenance side, the employees do not believe in the strategies, because of… of… (stammering) that gap I've just mentioned. The Engineer will develop the strategy on her own and then, she will expect Maintenance to implement somethings that are not level or whatever it is and all that, so, because of that RBO for them is not real something that is working or all that…"

The above views emphasize the importance of communication in implementation of new strategies. People respond better to invention if they had been involved from the on-set and they own the strategy as their own. Communication serves as a foundation for planning. All the essential information must be communicated to the managers who in-turn must communicate the plans so as to implement them.

The importance of communication in an organization can be summarized as follows:

1. Communication **promotes motivation** by informing and clarifying the employees about the task to be done, the manner they are performing the task, and how to improve their performance if it is not up to the mark.

2. Communication is a **source of information** to the organizational members for decision-making process as it helps identifying and assessing alternative course of actions.

3. Communication also plays a crucial role in **altering individual's attitudes**, i.e., a well-informed individual will have better attitude than a less-informed individual. Organizational magazines, journals, meetings and various other forms of oral and written communication help in moulding employee's attitudes.

4. Communication also **helps in socializing**. In today's life the only presence of another individual fosters communication. It is also said that one cannot survive without communication.

5. As discussed earlier, communication also assists in **controlling process**. It helps controlling organizational member's behaviour in various ways. There are various levels of hierarchy and certain principles and guidelines that employees must follow in an organization. They must comply with organizational policies, perform their job role efficiently and communicate any work problem and grievance to their superiors. Thus, communication helps in controlling function of management.

An effective and efficient communication system requires managerial proficiency in delivering and receiving messages. A manager must discover various barriers to communication, analyse the reasons for their occurrence and take preventive steps to avoid those barriers. Thus, the primary responsibility of a manager is to develop and maintain an effective communication system in the organization ([3]management studyguide.com/index.html). From the above discussion we see how important communication is and how the success of a project is entirely dependent on effective communication and employees' buy-in. The quote below illustrates how people feel about the buy-in:

"I think the buy-in seems to be poor to get it kicked off".

One of the participants pointed out that it is also part of humanity to resist change; literature supports that the main reasons for resisting change include:

- **Fear of the unknown/surprise:** This type of resistance occurs mainly when change is implemented without warning the affected stakeholders before the change occurs. When change (especially what is perceived as negative change) is pushed onto people without giving them adequate warning and without helping them through the process of understanding what the change will include and how their jobs/work will be affected, it can cause people to push back against the change due to their fear of the unknown.
- **Mistrust:** If the individuals in a department highly respect their manager because the manager has built up trust over a period of time, the team will be more accepting of any changes. If the manager is new and has not yet earned the trust of their employees (like my client), then mistrust can manifest itself into resistance to change.
- **Loss of job security/control:** This type of resistance often occurs when companies announce they will be restructuring or downsizing. This causes fear among employees that they will lose their jobs or be moved into other positions without their input.
- **Bad timing:** As the old saying goes, "Timing is everything". Heaping too much change on employees over a short period of time can cause resistance. If change is not implemented at the right time or with the right level of tact or empathy, it usually won't work.
- **An individual's predisposition toward change:** Differences exist in people's overall tolerance for change. Some people enjoy change because it provides them with an opportunity to learn new things and grow personally and professionally. Others abhor change because they prefer a

[3] http://www.managementstudyguide.com/importance-of-communication.htm (Downloaded 15th Jan, 2015)

set routine – these are usually the people who become suspicious of change and are more likely to resist (Quast[4]: 2012).

One of the managers pointed out that quality was compromised as a result of ineffective communication; this is how she described it:

"…we just start taking shortcuts because of this "rush, rush thing" and at the end it does not work well…"

"…*we only created long section of it on SAP PM, just for the PMs to run and even without the work packages. So, we tried and..and … (pause) to by-pass some processes and everything…"*

It is important for Eskom to effectively communicate new strategies on time for the future; for them to be successfully implemented. The managers express frustration about the issues of not being sensitized fully into new strategies. The managers fail to mobilize resources such as finances and motivating staff; in turn, compromise quality and just implement. The managers are mandated to implement the RBO strategy and their performance is measured against the RBO strategy implementation. The managers also complain of lack of technical know-how, which promotes supervision deficits in their managerial work.

Team work within the power stations is reported to be lacking tremendously; causing a lot of problems for the organization. Departments are working in segregation as affirmed by the following quotes from the study participants:

"…*Then, now, work together, as we realise that this RBO, we will never do anything, because it will never work without Engineering, without Maintenance, without work management. We need to work together, because it will never be successful in that way. We really need to try harder, to make work together."*

"… all the relevant departments, they must engage all of us and then, we try to implement it the way it is supposed to be".

"..*if a department head is positioned as the technical leader of a project, then, it is assumed that it is that department's project".*

The above statements by the study participants demonstrate lack of team work and team spirit among the different power station departments.

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[4]https://www.forbes.com/sites/lisaquast/2012/11/26/overcome-the-5-main-reasons-people-resist-change/#5e2d92ae3efd (Downloaded 15th Jan, 2015).

5.3.2. Time

Time for planning the RBO strategy implementation posed problems for the managers in that the time was inadequate in for the plenary of the implementation. Time required to involve implementers fully, into understanding the basics of the RBO strategy, benefits and why they had to use the RBO strategy. This is shown below by one of the participants:

"I mean that thing is for to carry out and to execute the roll out of the strategy. People need to be on board; everybody needs to be on board. What I'm saying is, if I don't have a head count and there is a system issue then I must make a plan".

"Yes, they told to wait implementing RBO, because it has gaps, in terms of classification of the plant. There after they introduced BPP strategy project."

For any strategy implementation to succeed the timing has to be right, in that all people who are involved in the implementation are ready. Spending time properly assessing the organizational readiness helps ensure that the capacity to sustain the implementation us attained in order to get the long-term value. Implementations that are carefully vetted have greater chance of achieving their intended impact.[5] The timing is important in that managers are able to set aside time and support the implementers.

"On time, on time!! What I noticed is that when, they bring projects; it's like today, we have BPP, next week or two weeks to come we have to comply and implement and the fact that we are being measured and do not comply, probably you have to answer to the GE or something like that".

The support is encompassed in the statement by one of the participants:

"We just said: let's do the PM because we wanted to comply. If it can be communicated well, to get a buy-in from managers first, in order for them to engage with the employees to get that focal support and all that!!"

"Buy-in, communication, and lack of support as we discussed above, in addition increased work load. Support would come from the department of Engineering; because they are the ones supposed to…pause… they are the first line of the process, because they start the strategy first and comes to us".

[5] www.readinessroadmap.org/projectreadiness (Downloaded 16th Jan,2015)

5.3.3. Staffing

All the participants in this study reiterated that they were short-staffed for the RBO strategy implementation. The participants pointed out that some employees were released for the strategy training:

"There, always, has been SAP training for relatively identified people, if I may say. The executors were maintenance personnel who worked on the plant, using SAP".

"*Training was provided for the senior technicians and technicians on data capturing, creating notification and work orders".*

"Remember, when the project was implemented, we were told that we need to release people from their normal duties, and here in this power station we do not have enough resources to even afford us freedom to do that…"

"…They identified the individuals to be part of the process and during, obviously, the roll out process; those individuals' roles were now re-defined…"

However, the people that went for training were from the power stations. The managers did not recruit new staff for the RBO strategy implementation; the trained employees were not released from their daily normal duties. The status quo increased the work load for these employees. This is how it was expressed by the participants:

"…only one technician was designated for RBO, which puts a lot of pressure on the individual. There are expectations from RBO side, while the person still has to carry out the daily work."

"I think RBO needs more people to implement the strategy. They are short staffed".

"Yes, more workload, increased paper work load".

"Extremely negative; more work, you think engineers like more work?"

In addition, staff issues include capturing data, creating notification and work orders into SAP. Others report inaccessibility to SAP system, while some insist that the shortage of trained staff is highly affected by staff turnover. Some trained staff resigns from the organization and untrained staff joins the power stations. The participants see these as a challenge, thus:

"basically we need a backup person or back up process; processes well defined, proper documentation on training, training packages that can talk to a new employee and he is able to study and understand the content; that is, what to do."

"I think all staff members need to be familiarized and oriented to the tool and how to use it".

5.3.4. Training

The training was highly appreciated by all participants. Though, participants pointed out some short falls on the selection criteria; that specific employees were selected to attend the training. The participants desired higher numbers for training. Some managers were not trained; such omissions hamper their supervisory role and unable to deliver effectively. When new employees join the department, systems' orientation becomes difficult. The participants expressed this notion as follows:

"we need… training packages that can talk to a new employee and he is able to study and understand the content; that is, what to do."

Isett et al. (2013:6) note that to successfully implement transformative change, management have to retrain existing staff to implement the new processes and conducted extensive training with new staff to understand the new roles they were to fulfil.

Some concerns that also emanated from the findings are that the training time was too short in comparison to the content that needed to be covered. The pass mark was said to be too high as well and that the trained personnel seem not to use the system. The quotes below verify the above researcher's observations:

"it is a lot of information within a short period of time".

"The pass mark is too high; given the time allocated to the training. I am happy with the content, though".

"……the theories used; the thing is you attend the training and if you don't use the tool, um… is not gonna be effective…."

In a nutshell people are happy about the training.

5.3.5. RBO strategy Implementation Process deficiencies

The study outcomes indicate that there are deficits within the progression of RBO strategy implementation. The sections below discuss the views and deficiencies of the RBO strategy implementation process pointed out by the study participants.

5.3.5.1. RBO strategy

The RBO strategy is regarded highly beneficial and effective by all participants. The participants expressed this notion as follows:

"For me, the benefit of RBO is it makes sure that all plant's components are catered for; because all PMs are available for each and every system on the plant."

"…. It makes sure that all components are being maintained and are given the attention they deserve. All plant components are maintained accordingly and are easier to track, if anything goes wrong; for example if you experience a breakdown or an incident it becomes easier to track what is not working well for us, to say on this component we have just maintained, the component is still not working, what can we do better?

In that way we sort of create a reference point. So, it is a good a good process, it will work for us…"

"Yes, it gives them an opportunity to do more on their plant analysis, more breakdowns and also understanding the operation's point as well as the spare requirements and I think, also, doing the exercise, they were able to identify constraints within their systems."

In the following section the short falls pointed out by the participants are encouraged to be improved in order to enrich the strategy implementation. It actually is clear that RBO is considered valuable.

5.3.5.2. RBO strategy shortfalls

Some of the participants shared their concerns and viewpoints on the strategy shortfalls. In support of the viewed shortfalls, some pointed out that too many strategy additions or changes are being introduced during implementation phase. The quotes below verify the above researcher's observations:

"It looks like the developers of the strategy didn't involve specific plant specialist, there were lots of unknown in the dropdown activity list. The GGCS codes are not completely listed."

"GGCS Codes Must be developed for all the C&I system components. Also the Fire Detection System Components (smoke detector, heat detector, flame detector, beam detector, Fire detection Control panels and control modules."

"The process is unclear with little to no help available. Where are the slurry pump GGCS? If coupled to GGCS does it cover more than 1 activity? Example. If I link my Ash pump to GGCS will greasing of bearings be included, gland adjusting for stuffing box or greasing of expeller seal. What happens if the RBO GGCS specifications don't meet the OEM's maintenance specs? …".

This point of introducing changes and strategic additions needs to be seriously considered before implementation in future; in order to facilitate strategy implementation success.

5.3.5.3. Management concerns of RBO strategy implementation

Management indicated that the introduction of too many projects done in a short period of time, results to loss of focus. The participants expressed this notion as follows:

"…… you will find that we put much effort, you sent people there, but, it was not fruitful because of the implementation; the way it was arranged, coordinated and the training; such introduction of the new project, you understand? If they can do it like that, the process will assist the organization. We do not deny that we can see the benefits, but, it is the way they are being handled! People negatively do not want anything to do with it anymore…"

"I think for me. It would be standardization. I think the biggest issue for me is the changing of goal post, the requirements; that is frustrating to me to this point, to get to the end results."

According to Sterling (2003:32) sometimes the strategies fail because they are ill conceived. Some of the elements of the RBO strategy were unsound because of misunderstanding the human factor dynamics in utilising the provided tools.

5.3.6. Qualitative Data Analysis Conclusion

The themes and categories, as well as the sub-categories clarify the conceptions power station management and personnel have about the RBO strategy implementation. The participants show that management was not sensitised during the conception of the RBO strategy. Therefore, it was difficult for management to buy-in and support the RBO strategy implementation. The status quo restrained communication between managers and implementers. In turn, managers were not able to collaborate and supervise the RBO strategy implementers; due to the issues related to change and lack of technical know-how.

Time for planning the RBO strategy implementation posed problems for the managers in that the time allocated was inadequate in for the plenary of the implementation; to involve implementers fully into understanding the basics of the implementation process and RBO strategy benefits.

In addition, the RBO strategy implementation process required human resources from the power stations. This increased the workload on the human resources as they were not release from their normal duties. The fact that the implementers were still doing their normal duties negatively affected the completion of the RBO strategy implementation milestones.

The trained staff resignations posed a challenge as new untrained staff had to take over. Nevertheless, as some managers were not trained, new staff orientation became difficult. In addition, managers' supervisory role and ability to deliver effectively was hampered.

The RBO strategy is regarded highly beneficial and effective by all participants. The participants stressed that new changes are being introduced during the implementation process; resulting into confusion for the implementers. The participants recommend that the point of introducing changes and strategic additions needs to be seriously considered before implementation; in order to facilitate strategy implementation success.

6. CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

Eskom's purpose is to provide sustainable electricity solutions to grow the economy and improve the quality of life of people in South Africa and the region. The electricity demand in Southern Africa plays a pivotal role in Eskom generation capacity. The country experienced the highest peak electricity demand in the year 2008, which led to load shedding to protect the national power system from the risk of a national blackout.

Nearly two-thirds of Eskom's power stations are beyond the midpoint of their expected lifespans. Given a tight supply-demand balance, Eskom frequently had to defer planned maintenance to ensure uninterrupted national power supply over the seven years. This has taken its toll on the generation fleet, the performance of which has become increasingly volatile.

Eskom can no longer afford the luxury of postponing maintenance. Eskom is committed to carry out planned maintenance. However, the unpredictable plant reliability and inadequacy of reserve margins predispose Eskom to deferred planned maintenance. The deferment delays the turnaround of plant performance. Eskom's unplanned capability loss factor (UCLF) has deteriorated to 13.3% between June 2014 and September 2014 (www.eskom.co.za). The UCLF is an indicator of plant performance: a higher factor means that power station units have tripped or had to be taken offline due to faults, or that a power station is producing less energy than it is contracted to as a result of unplanned setbacks. Space must therefore be created to do the necessary maintenance work.

6.1. Conclusions

The findings of the research are that though the RBO strategy has been proven effective in power utilities, the human dynamics in the implementation of processes play a pivotal role. The successful implementation of a strategy or process is governed by proper change management implementation initiatives.

OBJECTIVE 1: To evaluate the CMMS utilization by end-users at the coal fired power station.

The CMMS is well known in different departments responsible for the RBO strategy implementation. There is a significant use of the different sub-modules with preventive maintenance mostly used. It is of interest that the least used CMMS function is Asset Management. Even though, some of the respondents did not have the CMMS access, while some of the participants observed that some of the trained implementers do not request system access after training. The untrained novice employees did not have access to the CMMS.

In conclusion, the study results indicate that experienced respondents have access to the CMMS, while novice employees lack access. The CMMS is utilised by experienced respondents and less by the novice employees.

OBJECTIVE 2: To assess the level of quality of the information derived from the CMMS.

The respondents illustrated that the information quality retrieved from the CMMS for those who have access is sufficient. Consequently, the respondents with no access could not measure the information quality.

In conclusion, the study results show that experienced respondents were better equipped to evaluate the quality of information retrieve from the CMMS.

OBJECTIVE 3: To determine the extent in which human dynamics factors were considered in the RBO strategy implementation at the power station.

The study findings conclude that most of the study participants, were well informed of the RBO strategy, however, negatively accepted the RBO strategy; due to the grey areas of communication process. In addition, the respondents with working experience of more than 5 years knew the RBO strategy before on-site implementation. Yet, the majority of respondents that did not know the RBO strategy before on-site implementation were respondents with 2 years working experience. This observation proves to be true as the RBO strategy was implemented in the early 2000s and respondents with such working experience were not yet employed.

The results illustrate that the RBO strategy requires integrated working system for all the departments involved in the implementation. However, the participants reiterated that the working relationship of different departments was diverse, which indicate silo mentality. Each department key performance areas (KPAs) and goals are different and the only interface of departments is during meetings which mostly had poor attendance. Moreover, the respondents with 2 years working experience employees indicated being isolated during strategy implementation as they did not form part of the implementation team.

The targeted dates for implementation posed another huge problem. It was difficult to meet the targeted dates due to lack of resources solely dedicated to the RBO strategy implementation. Likewise, management was not seen to encourage strategy implementation over day to day plant operations by novice employees. The participants and respondents both reported increase in workload for the RBO strategy implementers.

In conclusion, the study results illustrate that human dynamics play a pivotal role in the success of strategy implementation. The following concepts were examined:

- Communication promotes employees motivation and positive attitudes;
- The novice employees were not trained; and
- The strategy impacted negatively by increasing the workload of the implementers

OBJECTIVE 4: To evaluate the level of support by management provided during the RBO strategy implementation at the power station.

The participants cited non-involvement in project planning as an obstacle. Timing for the RBO strategy implementation featured as a challenge for both the respondents and the participants. The participants pointed out that time were inadequate for the implementers; in addition, station managers did not fully understand the requirements of the RBO strategy. It is quite interesting to note that after the Reliability Basis Site Implementation preparation phase that was held; the station managers still did not fully understand the RBO strategy requirements.

The participants were unable to support and allocate resources for the RBO strategy implementation. Nonetheless, the majority of the respondents were aware of the RBO strategy requirements before implementation. In the meantime, the to-be implementers were not part of the buy-in phase. Additionally, management involvement during strategy implementation was not well translated to novice employees due to misunderstood roles and responsibilities.

Managers gave attention to the required adequate training to the implementers of the RBO strategy. Most of the new staff members were untrained; and were expected to implement the RBO strategy. The novice employees that had being to the training, brought the notion of frustration to the time allocated for training, this was also affirmed by the participants. In opposition, the respondents that had training found the training time sufficient and effective.

The novice employees found it difficult to participate in bottom-up communication due to lack of knowledge, skills and experience in the subject matter. The communication of new developments and regular progress reviews during strategy implementation seem to be one of the concern areas for the novice employees.

The participants are involved with the on-site strategy implementation. While, the novice employees are not seeing the involvement; due to lack of knowledge of management role and responsibility in the implementation process. The results demonstrate management commitment and support to the RBO strategy implementation. The novice employees' non-involvement in progress reviews restricts a meaningful contribution to the decision process.

In conclusion, the study results are in line with the literature that the main focus of management has been technical and financial details of any form of change. The associated human factors are normally overlooked. The human factor consideration is normally realised at the point of implementation failure.

Figure 6-1 presents the hierarchical breakdown of the research findings.

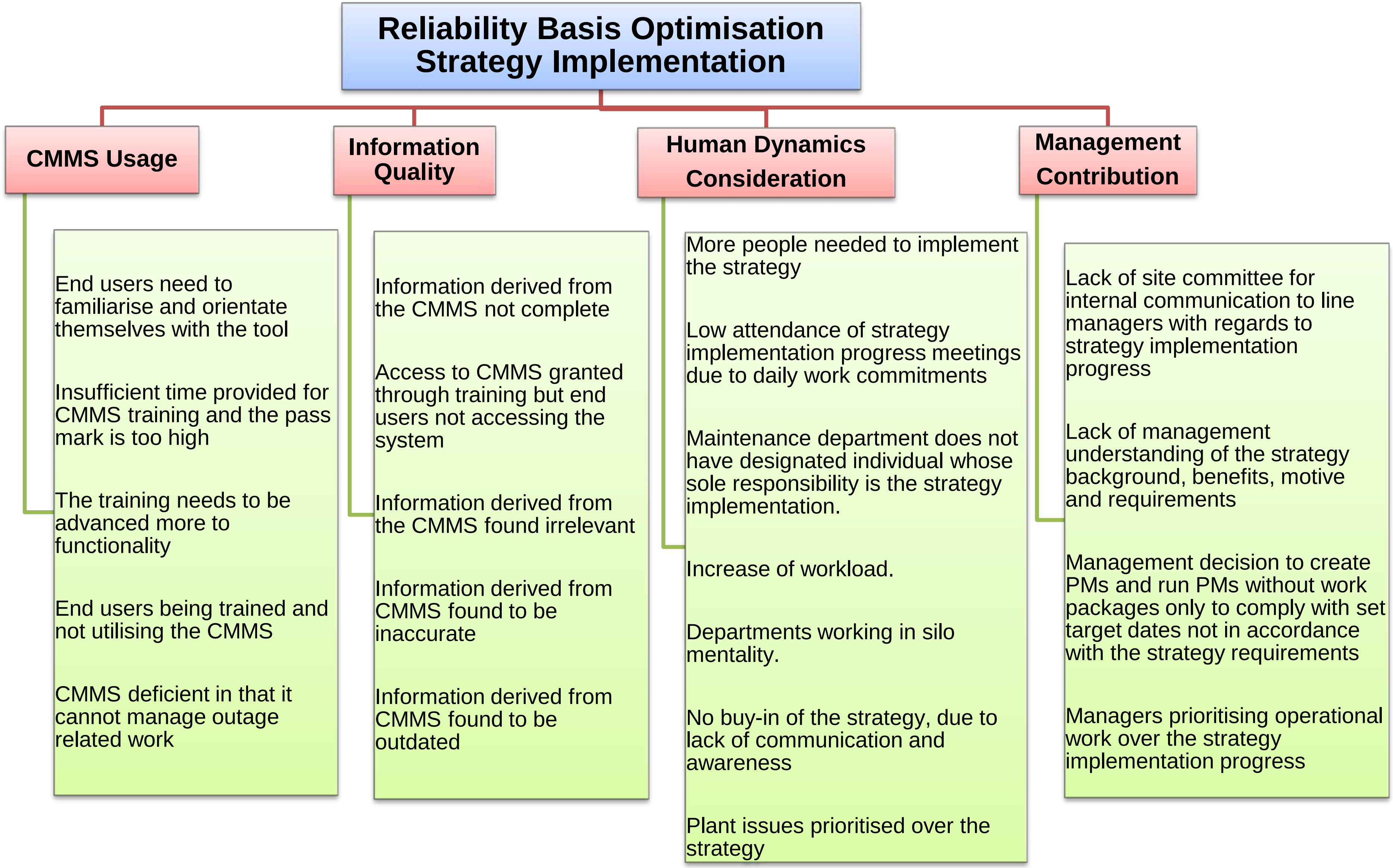

Figure 6-1: Hierarchical Breakdown of Research Findings

In conclusion the RBO strategy is highly appreciated and is found to be a good strategy that has prodigious benefits. The strategy has been noted for ensuring that all plant's components are catered for in preventive maintenance. The PMs are available for each and every system on the plant. The strategy has the ability to define the proper process, technical evaluation and break down.

6.2. Recommendations

This research study has brought out many interesting issues that can benefit the organization tremendously on consideration for all new strategies successful implementation.

It is recommended that the CMMS data integrity of the information retrieved from the system be occasionally audited on the information quality variables. The key performance indicators metrics must be defined and measured occasionally to ensure information quality.

It is recommended that the management team leaders need to be involved early during conceptualization stage, in order to buy-in and own the new strategies. The communication and support need to be continuous from the strategy custodians. There is niche need to have special experts to give support from the head office to all the power stations. The experts need to be available around the clock; should people need them to answer questions about the new strategy, especially in the early stages of implementation.

It has come out clearly in the findings that managers cannot provide required management support and focus if they do not fully understand the requirements and impact of the new strategy; so there is need to train supervisors on any innovations by the organization. The recommendation is that when a new strategy is introduced campaigns need to be instituted, in order to sensitize all employees.

Team building may sound like a simple activity, but, it raises lots of unforeseen problems. It is recommended that the organization needs to pay attention to this and act immediately. All departments are essential and important, but, need to be aware that organizations work as a system. They must employ the system theory approach, which advocates interdependency of all departments.

The training for the RBO strategy needs to be reviewed and address, there are grey areas pointed out by the study participants. The RBO strategy has been commended by all that it has many benefits and makes work more achievable. However, some respondents feel that the organization is not addressing the teething problems of this strategy, instate, and introduces new strategies such as (BPP) to rectify the problems.

All the managers commented the RBO strategy organizes work and answers the needs. However, it is recommended that the station need additional personnel to satisfactorily implement the strategy. It is also recommended that continuous workshops be held for the staff members in order to keep updates on the strategy, as well as on-going supervision and support from the strategy custodians.

Change management stood out to be a problem in the acceptance of new strategies; it is therefore seen as a great need to orientate personnel before implementation of all new future interventions. It is suggested that the orientation and buy-in be done in different groups, beginning with station managers, so they can sell the idea to their respective employees. It is further recommended that the CMMS standardization and preventive maintenance strategies inventory completion before implementation.

It is finally recommended that the Reliability Basis Site Implementation "Preparation Phase" content be revisited in order to validate its reliability.

In conclusion the researcher is emphatic that these recommendations are dearly looked at and action be taken in due course for the RBO strategy implementation success.

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APPENDIX A: Interview Guide

INTRODUCTION
I want to thank you for taking the time to meet with me today. My name is Keiso Tsekoa and I would like to talk to you about your experience in the implementation of the Reliability Basis Optimisation (RBO) strategy at Camden Power Station. I am one of the Eskom employees, currently in the Eskom Power Plant Engineering Institute (EPPEI) program registered for Master's degree at the University of Pretoria. Specifically the research project aims to identify the key hindering factors of the RBO strategy implementation related to Computerised Maintenance Management System (CMMS) application and Change Management philosophies. The interview should take less than an hour. I will be taping the session because I don't want to miss any of your comments. Although I will be taking some notes during the session, I can't possibly write fast enough to capture all the information. Because I will be recording, please be sure to speak up so that I don't miss your comments. All responses will be kept confidential. This means that your interview responses will only be used for this research project purposes. I will ensure that any information I included in the report does not identify you as the respondent. Remember, you don't have to talk about anything you don't want to and you may end the interview at any time. Are there any questions about what I have just explained? Are you willing to participate in this interview? ________________ ________________ ________________ Interviewee Interviewer Date (dd/mm/yyyy)

QUESTIONS

1. Before the implementation of Reliability Basis Optimisation (RBO) strategy, how were maintenance activities, on plant System equipment, determined? Please explain
2. How were the maintenance activities, on plant System equipment, recorded? Please explain
3. What benefit(s) do you envisage by the implementation of the Reliability Basis Optimisation (RBO) strategy, with regards to determining and recording maintenance activities at the power station? Please explain
4. What were the guidelines or training provided for SAP PM Application, in the implementation of the RBO strategy at the power station?
5. What worked well? Please elaborate
6. What would you do differently?
7. What were the guidelines provided for the Change Management philosophies e.g. communication, impact on employee workload, employee job security, training, management focus and management support; in the implementation of the RBO strategy?
8. What worked well? Please elaborate
9. What would you do differently?
10. What were some barriers, if any, that you encountered in the implementation of the RBO strategy? Please explain
11. How did you overcome the barrier(s)? Please elaborate
12. What effect, if any, do you feel the RBO strategy implementation has on your department? Increased staff moral? Increased interaction with other departments? Please explain
13. What recommendations do you have for future efforts such as this in the organisation?

CLOSING COMMENTS

Is there anything more you would like to add?

I will be analysing the information you and others gave me and submitting a draft report to the university in just over one month. I will be happy to send you a copy to review at that time, if you are interested.

Thank you for your time.

APPENDIX B: Survey Questionnaire

INTRODUCTION

In the past three years Eskom Asset Management and Business Productivity Program Team, initiated a peer review on the progress of RBO strategy implementation at the coal fired power stations. The outcome of the review indicated that there are numerous shortcomings and challenges in the implementation of the RBO strategy, at the coal fired power stations. The need of a research study to identify the key factors hindering the on-site RBO strategy implementation was identified.

A case study research project at Camden Power Station is been conducted to identify the key hindering factors of RBO strategy implementation related to Computerised Maintenance Management System (CMMS) application and Change Management philosophies.

You are receiving this questionnaire because you were identified as one of the people who are directly involved with the RBO strategy on-site implementation. This questionnaire is anonymous and all replies will be held securely and confidentially. The information will be used solely for the purpose of this research project. As part of this study, a similar on-line survey questionnaire is available in the following link https://www.surveymonkey.com/s/KLTSEKOA if preferable.

It would be very helpful if you would complete **ALL** the **QUESTIONS** in this questionnaire. **Please** choose the **answer** that best describes your view by ticking or completing the appropriate box.

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University of Pretoria

INSTRUCTION: *Please answer by choosing only ONE of the given responses and mark your choice with an **X***

SECTION A: DEMOGRAPHICS

1.	**Please indicate the department you belong to**
	Engineering
	Planning
	Maintenance
	Operating

2.	**Please indicate your Plant Area/Discipline**
	Boiler
	Turbine
	Auxiliary
	Operating Units
	Operating Outside Plant

3.	**Please indicate your years of work experience**
	0 to 2 years

	2 to 5 years
	5 to 10 years
	10 to 15 years
	+15 years

4.	**Please indicate your task grade**
	T 11
	T 12
	T 13
	P 13
	P 16/ M 16/ G 15
	P 17/ P 18/ M 17/ M18

5.	**Please indicate the highest level of education you have completed**
	Diploma
	National N. Diploma
	Bachelor’s Degree in Technology (B-Tech Degree)
	Master’s Degree in Technology (M-Tech Degree)
	Bachelor’s Degree (B.Eng or BSc Degree)

	Honour’s Degree (B.Eng Hons or BSc Hons Degree)
	Master’s Degree (M.Eng or MSc Degree)
	Other (please specific)

SECTION B: COMPUTERISED MAINTENANCE MANAGEMENT SYSTEM (CMMS) APPLICATION

6.	**I know what SAP PM is.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

7.	**Please indicate the SAP PM SUB Module(s) you are currently using. (you can choose more than one option)**
	SAP PM – EQM – Equipment and Technical Objects
	SAP PM – IS – PM Information System
	SAP PM-PRM - Preventive Maintenance
	SAP PM-SM - Service Management
	SAP PM-WOC - Maintenance Orders Management

	Other (please specific)

8.	**I have access to SAP PM**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

9.	**I have received training to use SAP PM to perform my duties.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

10.	**The SAP PM training was adequate to perform my duties.**
	Strongly Agree
	Agree

	Not Sure
	Disagree
	Strongly Disagree

11.	**I use the SAP PM for : (you can choose more than one option)**
	Work Order Management (Generating Work Orders)
	Report Management (Generating Reports)
	Preventive Maintenance Management (Implementing PM tasks)
	Material Management (tracking inventory in store)
	Asset Management (tracking and entering all equipment)
	Resource Management (Planning and Scheduling)
	Making Maintenance Optimisation Decisions
	Other (please specific)

SECTION C: COMPUTERISED MAINTENANCE MANAGEMENT SYSTEM INFORMATION QUALITY

12.	**The information I obtain from the SAP PM is sufficiently COMPLETE. i.e. I am able to obtain all information required to perform my duties:**
	Strongly Agree
	Agree

	Not Sure
	Disagree
	Strongly Disagree

13.	**The information stored in SAP PM is easily ACCESSIBLE. i.e. I am able to access all the information to perform my duties, from the SAP PM.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

14.	**The information I obtain from the SAP PM is RELEVANT. i.e. I am able to use all the information stored in the SAP PM to perform my duties:**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

15.	**The information I obtain from SAP PM is ACCURATE.** i.e. **I am able to obtain information confirming to the truth about the condition of my System:**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

16.	**The information I obtain from SAP PM is sufficiently UP-TO-DATE.** i.e. **I am able to obtain information prior or at the right time when required:**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

SECTION D: HUMAND DYNAMICS CONSIDERATION(S) DURING ON-SITE RBO STRATEGY IMPLEMENTATION

17.	**I knew about the RBO strategy before on-site implementation.**
	Strongly Agree

	Agree
	Not Sure
	Disagree
	Strongly Disagree

18.	**The RBO strategy requirements were timeously communicated before site implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

19.	**Currently the RBO strategy improvements are timeously communicated before on-site implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

20.	**The communication and interaction between different**

	departments is consistently communicated. i.e. I am able to know the progress of other departments regarding RBO strategy on-site implementation through internal communication.
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

21.	**With the RBO strategy successfully implemented on-site, I perceive NO risk of increased workload.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

22.	**With the RBO strategy successfully implemented on-site, I perceive NO risk of job loss.**
	Strongly Agree
	Agree
	Not Sure
	Disagree

	Strongly Disagree

SECTION E: MANAGEMENT CONTRIBUTION(S) DURING ON-SITE RBO STRATEGY IMPLEMENTATION.

23.	**Management gives attention to adequate training of SAP PM.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

24.	**Management gives attention to time required to learn.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

25.	**Management gives attention to bottom –up communication. i.e. Management allows communication from lowest level of the hierarchy to the top.**
	Strongly Agree

	Agree
	Not Sure
	Disagree
	Strongly Disagree

26.	**Management has been immensely involved with the on-site RBO strategy implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

27.	**Management has been willing to provide resources for the on-site RBO strategy implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

28.	**Management has been willing to make tough decisions during the on-site RBO strategy implementation. i.e. I was allowed to**

	go for SAP PM training when there was an on-going project.
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

29.	**Management has been consistent in communication during the on-site RBO strategy implementation. i.e. I am up-to-date with all new developments relating to the RBO strategy.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

30.	**Management has been holding of regular progress reviews since the inception of the on-site RBO strategy implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

SECTION F: FUTURE IMPROVEMENT(S) OF SIMILAR STRATEGIES IN A POWER GENERATION ENVIRONMENT.

31.	**The communication tool(s) used in this initiative were the most appropriate to deal with strategy implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

32.	**The SAP PM training program used, during RBO strategy implementation, is the most effective training program for new technology end-users during strategy implementation.**
	Strongly Agree
	Agree
	Not Sure
	Disagree
	Strongly Disagree

33.	**The management style used, for RBO strategy implementation, is the most effective management style for strategy implementation.**
	Strongly Agree
	Agree

	Not Sure
	Disagree
	Strongly Disagree

Please state any other comments/recommendations/suggestions you may have regarding strategy implementation at a power station.

____

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____

____

Thank you very much for taking your time to participate in this study.

PLEASE RETURN TO:

Keiso Tsekoa

E-mail: keiso.tsekoa@eskom.co.za

Fax: 086 600 9322

APPENDIX C: Interview 1 Transcription

Int: Introductions

Int: Before the implementation of Reliability Basis Optimisation (RBO) strategy, how were maintenance activities, on plant System equipment, determined?

Resp: Please skip the question,

Int: Ok, how were the maintenance activities, on plant System equipment, recorded?

Resp: Please skip the question.

Int: Ok, let's skip the questions; tell me, what benefit(s) do you envisage by the implementation of the Reliability Basis Optimisation (RBO) strategy, with regards to determining and recording maintenance activities at the power station?

Resp: RBO can retrieve and trace back maintenance history.

Int: What were the guidelines or training provided for SAP PM Application, in the implementation of the RBO strategy at the power station?

Resp: Training was provided for the senior technicians and technicians on data capturing, creating notification and work orders.

Int: What worked well?

Resp: Eh.., it was good training which only needs to be standardization, measuring benefits and activity planning, as well as checking area.

Int: What would you do differently?

Resp: I think all staff members need to be familiarized and oriented to the tool and how to use it.

Int: Were the guidelines included on site?

Resp: I am sorry, I cannot remember, as training was done a long time ago.

Int: What were the guidelines provided for the change management philosophies, for example, communication, impact on employee workload, employee job security, training, management focus and management support; in the implementation of the RBO strategy?

Resp: I am not aware of the requirements, but, I think RBO needs more people to implement the strategy. They are short staffed. I am not sure if I answered the question. However communication was clearly offered, more people were requested and added; hiring was done.

Management support was offered, yes, it was clarified to the managers; even to the people who come and go, orientation to the strategy was carried out.

Int: What worked well?

Resp: Yah, that is exactly what goes on in this power station.

Int: Ok, what would you do differently?

Resp: People's opinions differ; I personally met no major challenges towards communication.

Int: So you think nothing should be done differently from your side?

Resp: Yes, it is matter of change.

Int: I see. Tell me, what were some barrier(s), if any, that you encountered in the implementation of the RBO strategy?

Resp: From my personal experience, as I said earlier, no barriers were encountered.

Int: What effect, if any, do you feel the RBO strategy implementation has on your department? Increased staff moral? Increased interaction with other departments?

Resp: Eeeh… all departments are aware of the project, any minor problems are workable from other departments, we know what to do.

Int: What recommendations do you have for future efforts such as this in the organisation?

Resp: I want the organization to go out there and campaign about the project, as in the case of car accidents, in order for the people to be aware of the new strategy, which in turn, helps the organization. Tell the people about the strategy, its benefits, discuss, share ideas and inform people why the strategy needs to be implemented. This is what I could do.

Int: Ok, were the benefits discussed at the inception of the RBO to your satisfaction?

Resp: I do not remember them being discussed, but, I can see the benefits on implementation. It helps the planning to be much quicker and records the maintenance activities.

Int: Ok, so you are aware of these two benefits of the planning being quicker and maintenance activities recording and that it impose no problems.

Resp: Yaah, It is not a long time since we implemented, so we have not encountered any problems.

Int: Would you like to make any additions?

Resp: I think I need more time with the strategy.

Int: Is there anything more you would like to add?

Resp: No

Int: I will be analysing the information you and others gave me and submitting a draft report to the university in just over one month. I will be happy to send you a copy to review at that time, if you are interested.

Resp: Please send me a copy

Int: Ok, thank you for your time.

Key: Int= Interviewer

Resp= Respondent

APPENDIX D: Interview 2 Transcription

Int: Introductions

INTERVEIW 2 (two managers asked to be interviewed at the same time at this station)

Int: Before the implementation of Reliability Basis Optimisation (RBO), how were maintenance activities, on the plant system, determined?

Resp 1: We used a number of…eh.. what defect we have. We would determine check a number of work packages; any one could request any package or equipment and load it on SAP. The process was not channelled and controlled, the way it was. It was no project.

Int: Ok, so, before RBO, you were already using SAP PM?

Resp 2: We normally used OEM manual, incident reports or investigation reports; when there was an issue people would request for work packages to be loaded. It was like that, whereby there was no structure like RBO. Anybody could raise a work package to say what needs to be done, depending on the plant history and incident report.

Int: How were maintenance activities, on plant system equipment, recorded?

Resp 1: The answer has been discussed above.

Int: What benefit(s) do you envisage by the implementation of the Reliability Basis Optimisation (RBO) strategy, with regards to determining and recording maintenance activities at the power station?

Resp 1: For me, the benefit of RBO is it makes sure that all plant's components are catered for; because all PMs are available for each and every system on the plant.

***Resp 2**:* Because we were always on reactive mode; we always reacted when something happens.

Int: What were the guidelines or training provided for SAP PM Application, in the implementation of the RBO strategy at the power station?

Resp 1: There, always, has been SAP training for relatively identified people, if I may say. The executors were maintenance personnel who worked on the plant, using SAP. We would, then, request them to do SAP PM, and then some of the engineers as well were trained on SAP.

Resp 2: *Ya*h.. Engineers were trained.

Int: What worked well?

***Resp 1*:** What worked well is that any one has access to SAP PM, even if you were trained on SAP PM 1., but, whether they are using it, is another thing. I really do not know if they are using it.

Resp 2: In addition, the training is practical; they show you what to do, even when you are doing SAP PM1.

Int: What would you do differently?

***Resp 2**:* What I can comment about is the evaluation; it is a lot of information within a short period of time.

***Resp 1*:** The pass mark is too high; given the time allotted to the training. I am happy with the content, though.

Int: What were the guidelines provided for change management philosophies, for example, communication, impact on employee workload, employee job security, training, management focus and management support; in the implementation of the RBO strategy?

Resp 2: I am not sure of the communication for RBO, if it was done. What I can comment on is the work load, from maintenance side only one technician was designated for RBO, which puts a lot of pressure on the individual. There are expectations from RBO side, while the person still has to carry out the daily work. When they realised that it did not work, they stopped the implementation of RBO project.

Int: Are you now discussing the communication or work load?

***Resp 1*:** We are discussing the whole change management philosophy; which was not properly followed. There was no structure, no enough support, because it was not dedicated its own time.

Resp 2: We are not supposed to be where we are today; we should be truly 100% complete, if it was done right.

Int: Please focus on communication, training and support.

***Resp 1*:** Remember, when the project was implemented, we were told that we need to release people from their normal duties, and here in this power station we do not have enough resources to even afford us freedom to do that. Another issue is that one would set up meetings regarding RBO, but, people do not attend due to their daily commitments.

Int: What worked well?

Resp 2: What worked well was the communication from the Engineering department; they understood the process well. They attended workshops and training. They were also in constant communication with MCoE. Maintenance department did not have such support, because even the designated person, who was responsible for overseeing the RBO project, was not released from his daily duties; at least Engineering had some one specific to consult for any problems.

Int: Ok, I see, would you do differently?

***Resp 1*:** I think, we need to form the internal work group; that is, a site committee as stipulated in the guidelines

Resp 2: If we had a work group that communicates with the line managers, for them to buy into this, so that they are told how the project would benefit the power station. Then, they would make sure they allocate the people for the project; because it is something that runs for a few months. People can go back to their daily activities. If it had been communicated very well by explaining the whole process, the benefits to the station and everything; everybody wants to understand the reasons of the project and the whole process. It makes you, even yourself as a manager, to participate, so some of us, even line managers did not understand the background, even the senior technicians did not understand. We just said; let's do the PM because we wanted to comply. If it can be communicated well, to get a buy-in from managers first, in order for them to engage with the employees to get that focal support and all that!!

Int: Ok, I see, you are very vocal about the communication for change management and you have a way forward! What were some barriers, if any, that you encountered in the implementation of the RBO strategy?

***Resp 1*:** Buy-in, communication, and lack of support as we discussed above, in addition increased work load. Support would come from the department of Engineering; because they are the ones supposed to…pause… they are the first line of the process, because they start the strategy first and comes to us.

Resp 2: I support that, yes!!

Int: Ok, how did you overcome the barriers?

***Resp 1*:** We are still trying to overcome them.

Resp 2: At that time we did not even attempt a matter of….pause… we were measured on this thing; were running out of time, we agreed "let's implement", so when we realised that it is not going anywhere, we tried and… and…(pause) we only created long section of it on SAP PM, just for the

PMs to run and even without the work packages. So, we tried and ... and … (pause) to by-pass some processes and everything. So, we now, to try; now to, that's when we now try to attempt to close those. We still trying.

Int: Ok it has been very difficult!

Resp 2: Because there are still gaps and all that, until everybody manages to play their own part and be finished with it. Then, now, work together, as we realise that this RBO, we will never do anything, because it will never work without Engineering, without Maintenance, without work management. We need to work together, because it will never be successful in that way. We really need to try harder, to make work together.

Int: Ok, what effect, if any, do you feel the RBO strategy implementation has on your department? Increased staff moral? Increased interaction with other departments? Please explain.

Resp 2: From the Maintenance side, the employees do not believe in the strategies, because of… of… (stammering) that gap I've just mentioned. The Engineer will develop the strategy on her own and then, she will expect Maintenance to implement somethings that are not level or whatever it is and all that, so, because of that RBO for them is not real soothing that is working or all that…

Int: So, you are saying there is no buying-in from the employees?

***Resp 2*:** Yes, I do not think is because of the… (pause) the RBO is a good process. It gonna benefit us, work well for us, but, the way it has been handled, the whole engagement between; the sections without the departments. It makes them to be totally against RBO in general.

However, the RBO process is going to benefit us. It makes sure that all components are being maintained and are given the attention they deserve. All plant components are maintained accordingly and are easier to track, if anything goes wrong; for example if you experience a breakdown or an incident it becomes easier to track what is not working well for us, to say on this component we have just maintained, the component is still not working, what can we do better?

In that way we sort of create a reference point. So, it is a good a good process, it will work for us; as long as we implement it the way it is supposed to be, all the relevant departments, they must engage all of us and then, we try to implement it the way it is supposed to be.

Int: Am I getting it right that you feel that there is a problem in the interaction and lack of collaboration between the departments; would you also share what would be causing such discrepancies?

Resp 2: It is not only RBO; in general, it is what we are experiencing in the power station as a whole. You understand, even in the daily activities, it is still like that, everybody is pulling away… (gestures).

Resp 1**:** The other thing is that as we said, we are short of staff, we lack resources, we, even heard it from the engineers, if you ask them, “please complete this activity (related to RBO strategy)”. They would rather prioritize the plant issues over the strategies. They do not realise that the strategy will reduce the plant failures. So, maybe, more training, more workshops, if like the project owners of RBO, people who implement, if they can see that they visit the stations more; understand? The visits must create awareness, buy-in… (Interruption) RBO and understand the benefits of RBO?

Resp 1**:** Yes, so that they can emphasize the importance of the project. It is not obvious to understand for example, if a department head is positioned as the technical leader of a project, then, it is assumed that it is that department’s project. They do not realise that the project involves and needs to be implemented by all the departments of the power station. They see it as something added to their work load. I think, as I am saying, we need to get support from you, guys. You are from MEGAWATTS, eh..? (Laughter)

Int: What recommendations do you have for future efforts such as this in the organisation?

Resp 1**:** As I said, awareness sessions and training; because of, for example, if I make an example, there is another one (Project), that is um...taking place, right now in Camden, the one for BPP strategies. They promised training for all the people involved, up to now, the project is carrying on; no one has been trained! We have given names of people, so, that people may be trained, in order that people can understand what this is all about. We still have more questions than answers with BPP strategies; same as this RBO.

So, if, we still have these loop holes, like the people who came up with the project, um... maybe they are four, who are running the project, neh...; you go to A, he gives you an explanation, you go to B, he gives you another explanation, you go to C, he puts you into a more confusion mode than A. So, now, people coming up with these projects have to understand that we are not waiting for projects, neh..? They should make the processes simpler for us, so that we know what to do, on time, on time (chorus); on top of what we are doing at the power station!

Resp 2**:** On time, on time!! What I noticed is that when, they bring projects; it’s like today, we have BPP, next week or two weeks to come we have to comply and implement and the fact that we are being measured and do not comply, probably you have to answer to the GE or something like that. So, if they can communicate in time, to say in...(Stammering) in the next financial year, there is a project coming, get prepared! This is what we need, training, some of them, we just start taking shortcuts because of this "rush, rush thing" and at the end it does not work well, like the RBO. We put our efforts in everything to say "let's implement", or maybe for some months; it did not work, it was wasted.

So, even this BPP in the long run, you will find that we put much effort, you sent people there, but, it was not fruitful because of the implementation; the way it was arranged, coordinated and the training; such introduction of the new project, you understand? If they can do it like that, the process will assist the organization. We do not deny that we can see the benefits, but, it is the way they are being handled! People negatively do not want anything to do with it anymore. We are saying: "MCoE MEGAWATTS, NO, those people don't know what they are doing".

***Resp 1*:** Yes, they told to wait implementing RBO, because it has gaps, in terms of classification of the plant. There after they introduced BPP strategy project.

***Resp 2*:** Yes, RBO was not thought thru, in terms of what was needed.

***Resp 1*:** You can imagine our frustrations, confusion and all of that (Laughing). I stress, before these projects are implemented, pilot projects need to be carried out to see if such projects will be feasible or not.

Int: Is there anything more you would like to add?

Resp 1 & 2: No

Int: I will be analysing the information you and others gave me and submitting a draft report to the university in just over one month. I will be happy to send you a copy to review at that time, if you are interested.

Resp 1& 2: Yes, we would be happy to review your work

Int: Ok, thank you for your time.

APPENDIX E: Interview 3 Transcription

Int: Introductions

Int: Before the implementation of Reliability Basis Optimisation (RBO) strategy, how were maintenance activities, on plant System equipment, determined? Please explain.

Resp: Are you referring to this station (Name) or to Eskom as a whole?

Int: to this power station (Name)

Resp: Eeh… maintenance activities were basically carried out based on the so called OEM philosophy. OEM's were contracted on the specific plant to carry out routine maintenance, eeh… PM and also outages.

Int: Ok, how were the maintenance activities, on plant System equipment, recorded?

Resp: Eeh…they were actually based on the strategies, when we started here; we started using TERMAC a long time ago.

Int: can you spell it for me and tell me what it is all about?

Resp: (spells) TERMAC is the same maintenance system as, eeh… you load the defect as in SAP, the defect is generated, then, the work gets, eeh… and activity gets done, then, obvious the history gets recorded. Some decisions were based on obvious inspections and regimes that were carried out on RTS before the station may return to service.

Int: ok.

Resp: maybe obviously the decisions were based on the OEMs.

Int: philosophies?

Resp: Yes.

Int: What benefit(s) do you envisage by the implementation of the Reliability Basis Optimisation (RBO) strategy, with regards to determining and recording maintenance activities at the power station?

Resp: I think RBO strategy, umm…I think it, it is, let me put it this way: it defines the proper process and what can I say, eeh…technical evaluation, break down. Obviously from utilizing the strategy and taking it through the maintenance process it encompasses a whole lot.

Int: hmm

Resp: The maintenance activities in detail for any specified equipment.

Int: I see, what were the guidelines or training provided for SAP PM Application, in the implementation of the RBO strategy at the power station?

Resp: Not really guidelines. Since we started roll out the RBO here in this power station. There is, however, a specific program for implementation. As I said, from greater to great and in that specific program the SAP PM application requirements were stipulated and also three stakeholders were identified, they were needed to attend the training sessions and obviously form a compliance point of view, application usage and implication was measured.

Int: Ok. Application usage?

Resp: Yes, application usage is like the utilizing system and now gaining benefits. From what the history is found from the philosophy.

Int: Ok.

Resp: So, basically that determines now failure of the plant or no reduction.

Int: Ok. What worked well?

Resp: I can talk for myself… (laughs)….

Int: Ok. Did you attend SAP training?

Resp: Yes, I mean I've been utilizing it before I even came to this power station. I was trained.

Int: Ok. The training that they offered; what worked well of SAP PM; was it the practical or the theoretical part of it?

Resp: I think the practical, for me it seems practical; the theoretical, the theories used; the thing is you attend the training and if you don't use the tool, um… is not gonna be effective. So, I think practice.

Int: Hmn…

Resp: Practice makes perfect, for this process and you also identify…uh…how can I put it? You know, you have to get the basics and then, you get advice, but, you find other tools or functionality, let's put it this way, functionality within the system that obviously offers you greater knowledge and …uh… with regard to your system, for me it is basically an overview to a higher level of engineering.

Int: What would you do differently, because you mentioned that when you work more on the system, we identify more functionality, so, maybe that program does not cover all the functionality?

Resp: Basics.

Int: Basics?

Resp: Yah... maybe we need to advance it to more functionality.

Int: What were the guidelines provided for the change management philosophies? For example communication, impact on employee workload, employee job security, training, management focus and management support; in the implementation of the RBO strategy?

Resp: No, I never went for any change management process in RBO. I will be honest I never went.

Int: So, according to the implementation procedure or guidelines they did not include change management philosophies?

Resp: No, I have never seen change management philosophy. Maybe they did it somewhere, but, I personally have not had one on one change management philosophies. Maybe from communication to say: "this is a program, this is the roll out plan for this power station and ...uhm...obviously the RBO meetings we held to measure the process of implementation and the timeframe we agreed on and executed. You are talking anything, job security, management focus; obvious management support was there, because it was driven from the executive management of the power station and the roll out.

Int: What work well with regard to change management?

Resp: What worked well is the support.

Int: Ok, from head office or from where?

Resp: Yes, from the head office. Obviously, we had to buy-in to support because we had to implement here. So, I think, it is a good head office support and I think good tracking tool of the implementation.

Int: What did not work well? What would you do differently?

Resp: I think for me. It would be standardization. I think the biggest issue for me is the changing of goal post, the requirements; that is frustrating to me to this point, to get to the end results.

Int: Ok, I see you are really frustrated.

Resp: So, you are with me to what I just said. Obviously, I do understand because it was the… it was the infant stage and teething problems that were taking place. I think the implementation; the whole roll out process should have been done differently.

Int: How differently?

Resp: Maybe, one thing that was the cause; they identified the individuals to be part of the process and during, obviously, the roll out process, those individuals' roles were now re-defined, some left the process and you'll sort of end up in a delay in execution, because the people with those skills are no longer here. You're with me?

So, basically we need a backup person or back up process; processes well defined, proper documentation on training, training packages that can talk to a new employee and he is able to study and understand the content; that is, what to do. It becomes a rescue when management changes, because I had the training, while the executive did not get the training. "I do n't know how to deal with this, nobody knows, obviously I don't an answer to this".

Int: What were some barriers, if any, that you encountered in the implementation of the RBO strategy?

Resp: I think the "Silo mentalities"; trying to all marry different departments; that is. Not knowing how to adapt the integration process and then, we have our monthly meetings, where we discuss all programs and their implementation issues. I think the buy-in seems to be poor to get it kicked off.

Int: Uh…what effect, if any, do you feel the RBO strategy implementation has on your department? Increased staff moral? Increased interaction with other departments? Please explain.

Resp: Extremely negative; more work, you think engineers like more work?

Int: Can you explain more, on the negativity; is it more work you are referring to?

Resp: Yes, more workload, increased paper work load, because you know engineers do not like paper work, I included. I think the process is right; we need to see the results of the work investment.

Int: What do you mean by work investment?

Resp: If you have done paper work and you put all the strategies in place, we need to see if it is working for us. So, that it is not all in vain.

Int: From the engineering department side, with regards to maintenance strategies in place is there a feel or notion that system engineers are getting to know their systems?

Resp: Yes, it gives them an opportunity to do more on their plant analysis, more breakdowns and also understanding the operation's point as well as the spare requirements and I think, also, doing the exercise, they were able to identify constraints within their systems.

Int: What recommendations do you have for future efforts such as this in the organisation?

Resp: While it is a good strategy; it is a worthwhile strategy because of the new and young people that are joining the organization. It teaches them the proper basis to understand the systems and the plant. I'm speaking from engineering side, so, I think somebody coming in, with the strategy you read through. I think you already have the know-how of 80% of your plant, the rest of the 20% you have to get your hands dirty; it is not going to give you the detailed details of the plant component breakdown.

Int: But, on the implementation side, what would you recommend?

Resp: from the implementation side, it is the implementation strategy on site or taking the strategy and implementing it?

Int: implementation strategy on site.

Resp: I think the one thing is the change management, remember this was done on very senior management level, then, it was passed on to the rest; station management to take it through the engineering processes and to the other departments. There were lots of high level presentations given, but, what I am saying to you, when you see a lot of acronyms, abbreviations and all of that, you are not going get it the first round of understanding; what is needed from you. Maybe, as well people were asked to use this template, this strategy on the ground. They needed to understand why I'm supposed to answer these questions, exactly why I do I need to go through this!

Int: Is there anything more you would like to add?

Resp: No

Int: I will be analysing the information you and others gave me and submitting a draft report to the university in just over one month. I will be happy to send you a copy to review at that time, if you are interested.

Resp: Yes, I will be happy to review your work

Int: Ok, thank you for your time.

APPENDIX F: Survey Questionnaire Comments / Recommendations / Suggestions

Resp 1: None

Resp 2: It looks like the developers of the strategy didn't involve specific plant specialist, there were lots of unknown in the dropdown activity list. The GGCS codes are not completely listed.

Resp 3: More time is needed to train new employees. I feel lost at the moment but I with time I will be fine.

Resp 4: RBO will have some improvement to the plant availability and reliability, but it take a lot of engineers time & not to mention financial constraints.

Resp 5: It is important that for the implementation of such strategies the following to be considered at all times: 1) Maintenance skill gab, 2) Number of manpower for capturing into SAP once strategies are finalised, 3) Continuous reviewing of strategies is not done timely.

Resp 6: I strongly believe RBO was not given sufficient attention that it deserves. I forsee poor sustainability of the program should it not get the required attention. I recommend thorough communication and roadshows to enhance the project. Regular awareness as well.

Resp 7: GGCS Codes Must be developed for all the C&I system components. Also the Fire Detection System Components (smoke detector, heat detector, flame detector, beam detector, Fire detection Control panels and control modules.

Resp 8: 1) Eskom is not fully staffed to handle the proper implementation of RBO.
2) The SAP system is deficient in that it cannot manage outage related work.

Resp 9: I have not done SAP PM training and have no access to the SAP PM system; therefore I have not been able to answer a substantial amount of the questions posed.

Resp 10: Maintenance strategies do not get to a point where the maintenance tasks are loaded on SAP.

Resp 11: The process is unclear with little to no help available. Where are the slurry pump GGCS? If coupled to GGCS does it cover more than 1 activity? Example. If I link my Ash pump to GGCS will greasing of bearings be included, gland adjusting for stuffing box or greasing of expeller seal. What happens if the RBO GGCS specifications don't meet the OEM's maintenance specs? Lose warranty of pump? One does not rewrite your BMW's maintenance plan. Why are we not using OEM's maintenance plans?

Resp 12: The organisation should look at adding resources in a power station who will assist employees during implementation of the RBO strategy since it's not a short process.

Resp 13: Sometimes it feels that not all managers are in the same boat on what needs to happen next with RBO. And that some managers have too many meetings to make time for your opinion.

Resp 14: In my opinion the time give to implement changes is limited; taking into consideration the fact that the system engineers also have to day to day duties activities as required by his/her job description. This results in the quality being compromised. Well done maintenance strategy makes it easier for maintenance activities to be implemented.

Resp 15: More Communication and awareness is required so that every stakeholder may understand and participate as expected. Team Work is also recommended especially among Engineering, Operating and Maintenance.

Resp 16: We need more communication and awareness about RBO strategy and implementation on site.

Resp 17: I believe that the RBO is the good management tool or model, but the proper change management process was not followed, it is the human nature to resist to change but at least if it was communicated properly. However we requested the meeting where we can list and deal with our challenges. I believed this time we will get the certifying solutions.