SAAMA2019 CONFERENCE

Analysing Spare Parts Management Business Processes using Failure Modes and Effects Analysis and Delphi Methods

Ronewa E. Goliada

Jasper L. Coetzee

15 May 2019

Layout of the presentation

- Introduction
- Research problem
- Objectives
- Methodology
- Results
- Conclusions

Introduction

- Power stations make use of engineered systems during the production of electricity.
- The systems are susceptible to failure, and require extensive maintenance.
- The purpose of such maintenance is to:
  - restore functionality,
  - and to improve reliability.

Introduction

- What makes maintenance possible?
  - Time, Labour, and Spare parts

Introduction

- The focus of this presentation is **spare part management**
- Spare part management ensures:
  - **availability** of the **correct** spare parts
  - the **required amount** of spare parts
  - the spare part **holding cost is low**
- These objectives are realised through optimal performance of related tasks by Asset Management business processes.

Problem

- High number of “unwanted” spare parts
- Unavailability of “necessary” spare parts

Research Problem

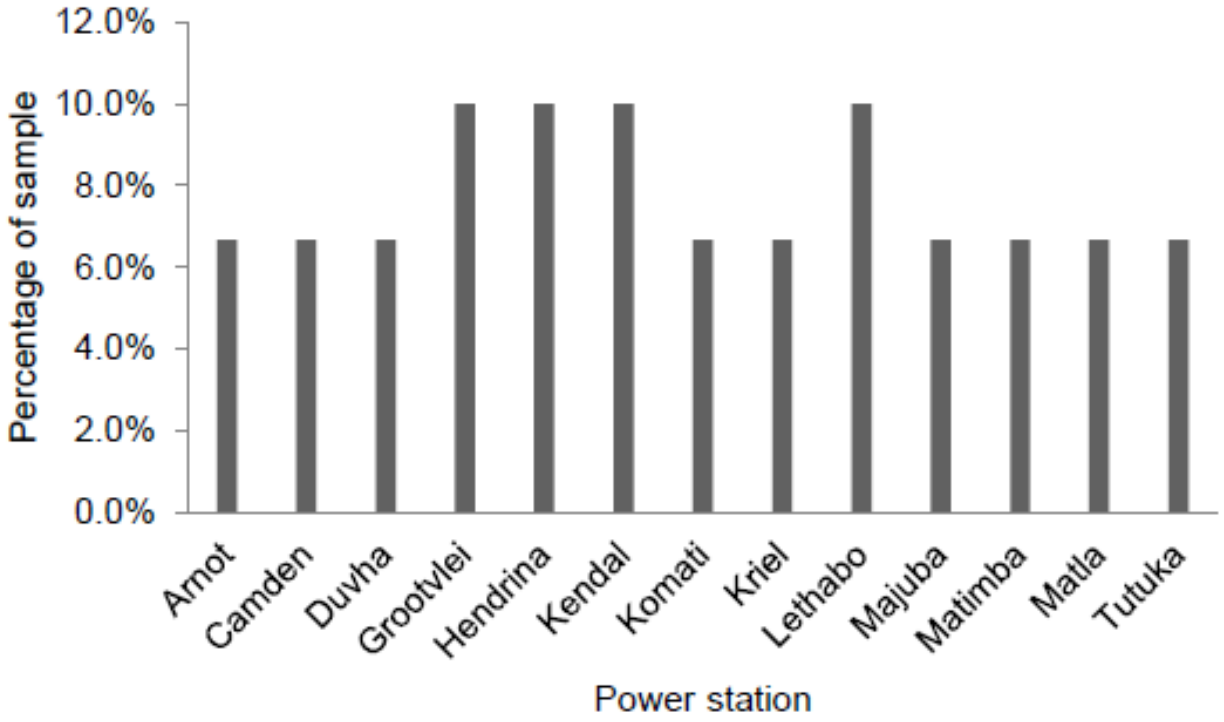
- No rigorous analysis of the Asset Management business processes.
- Drivers of inefficiency not established.
- Potential to impact return on the Asset Management investment.

Objectives

- The aim of the research was thus to undertake a rigorous analysis of spare part management business processes to improve their support of the overall plant operation.
- To fulfill this aim, the following objectives were set-out:
  - Establish the nature of failures in spare part management business processes in South African power stations.
  - Determine the causes of these failures.
  - Classify the failures according to significance

Unit of Analysis and Sampling

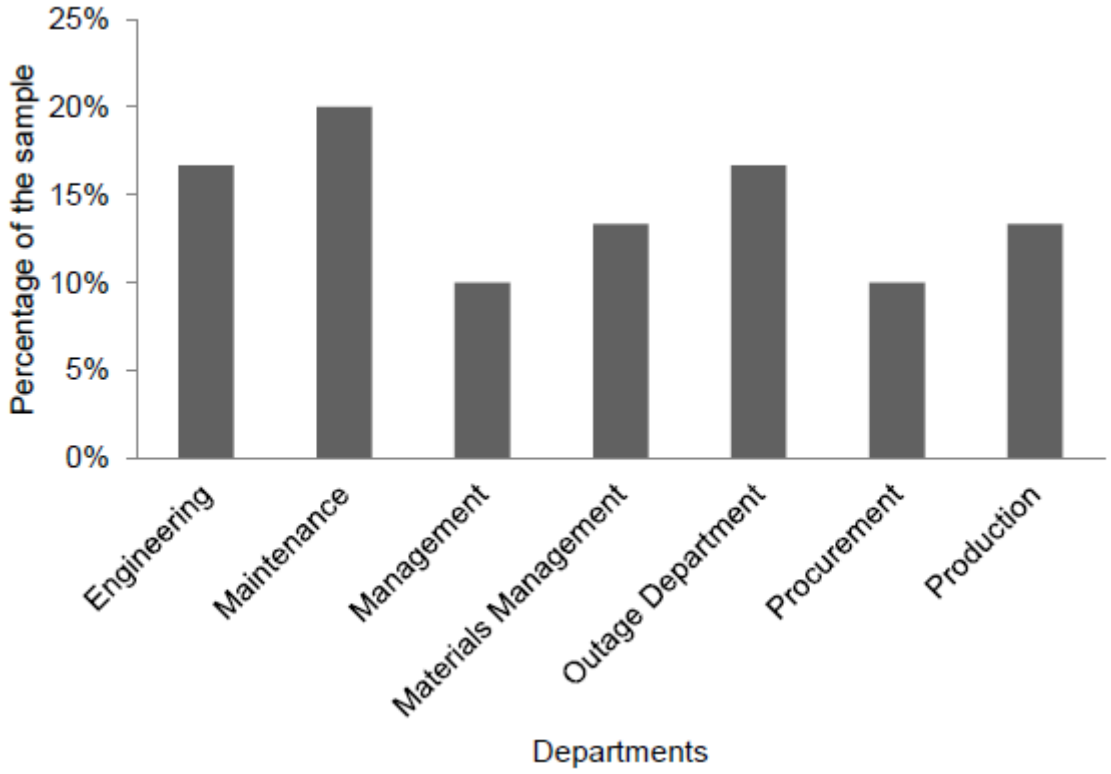
Thirteen coal-fired power stations in South Africa.



SAAMA2019 CONFERENCE

Unit of Analysis and Sampling

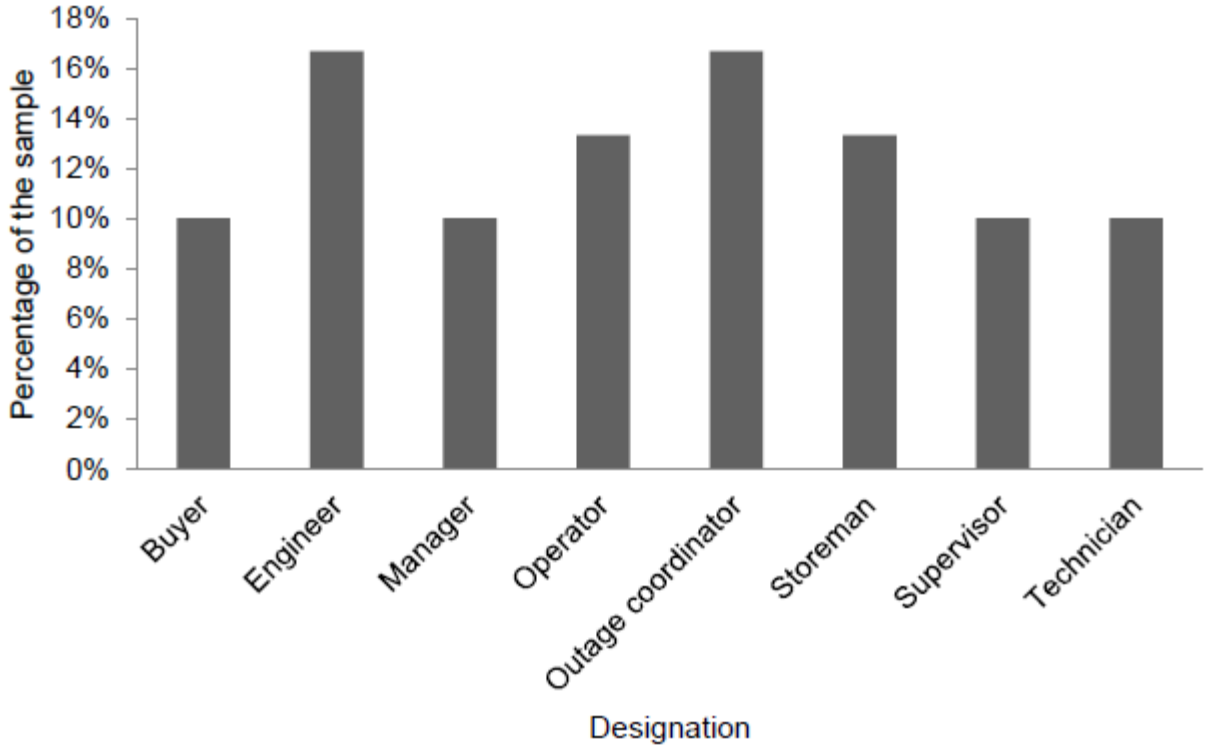
Purposive sampling used to select **thirty** participants



SAAMA2019 CONFERENCE

Unit of Analysis and Sampling

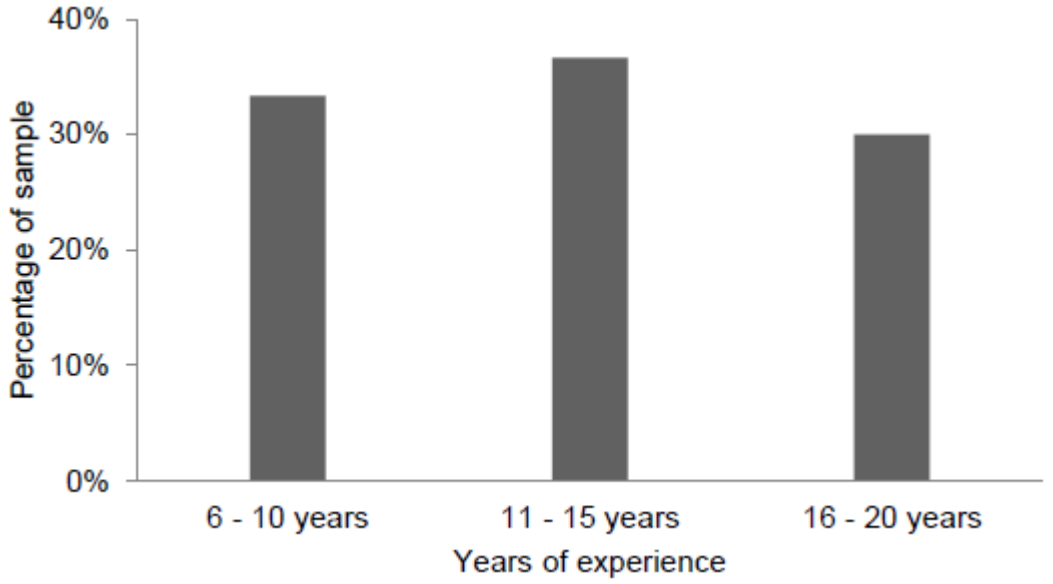
Purposive sampling used to ensure fair representation of Asset Management practitioners



SAAMA2019 CONFERENCE

Unit of Analysis and Sampling

Purposive sampling used to ensure that experienced Asset Management practitioners are selected for the study



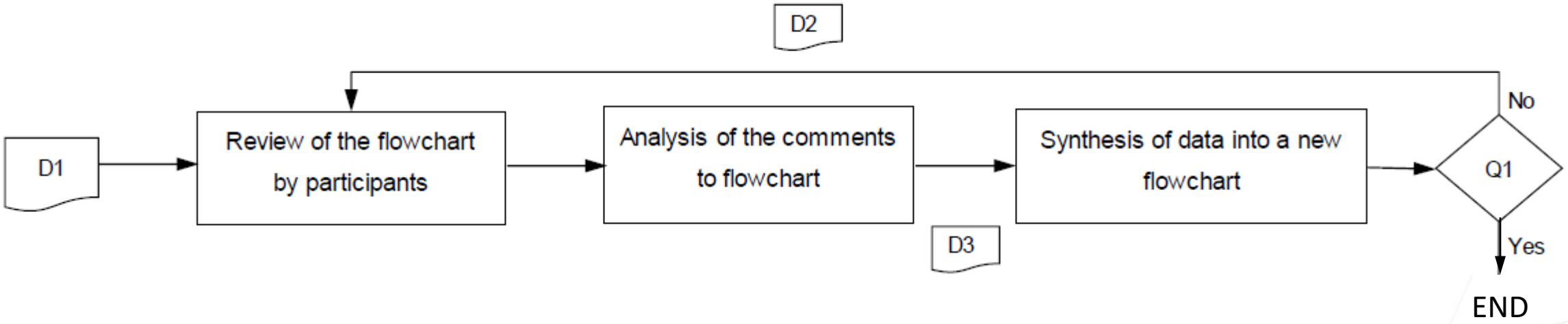
SAAMA2019 CONFERENCE

Methodology

- The study was both qualitative and quantitative.
- Reason? – *complementarity* and *development.*
- The study was in two phases.

Documentation of the Power Station Spare Part Management system

- Sources used - existing literature, company procedures, and data from research participants.

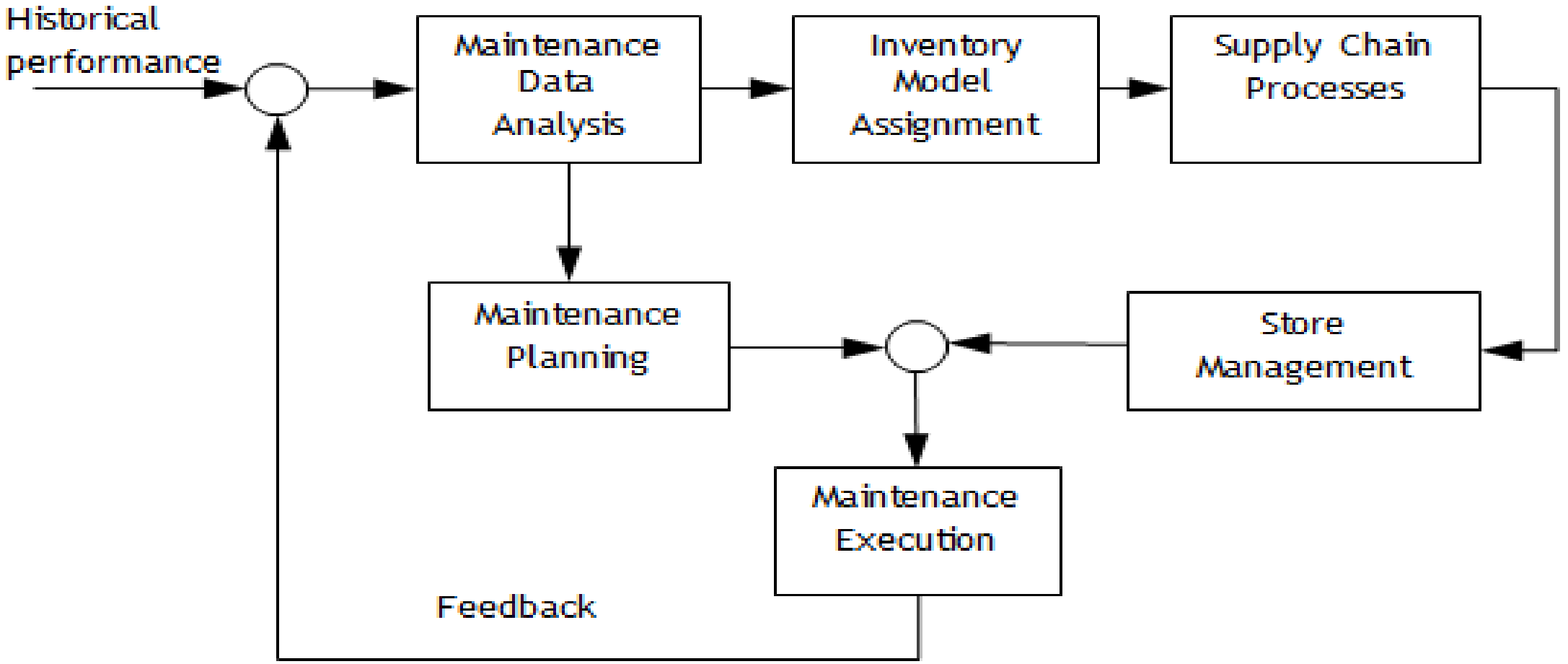


SAAMA2019 CONFERENCE

Documentation of the Power Station Spare Part Management system

- A Delphi approach was used in order to get convergence of opinions on the spare part management system.
  - Summarise opinions into an anonymous report for that round.
  - Provide the report to participants.
  - Encouraged participants to revise their earlier positions in light of the average opinion of the group, or provide reasons for maintaining their positions.
  - Repeat the process until there is convergence of opinions.

The Power Station Spare Part Management system



Process Failure Mode and Effect Analysis (PFMEA)

- Failure Modes and Effects Analysis (FMEA) - a design tool.
- In Asset Management it is used extensively as part of Reliability Centred Maintenance (RCM)
- The methodology is well-known for identifying functional failures in physical systems.
- Here it was adapted to handle the analysis of business processes.
- Hence the renamed form, Process Failure Modes and Effects Analysis (PFMEA).

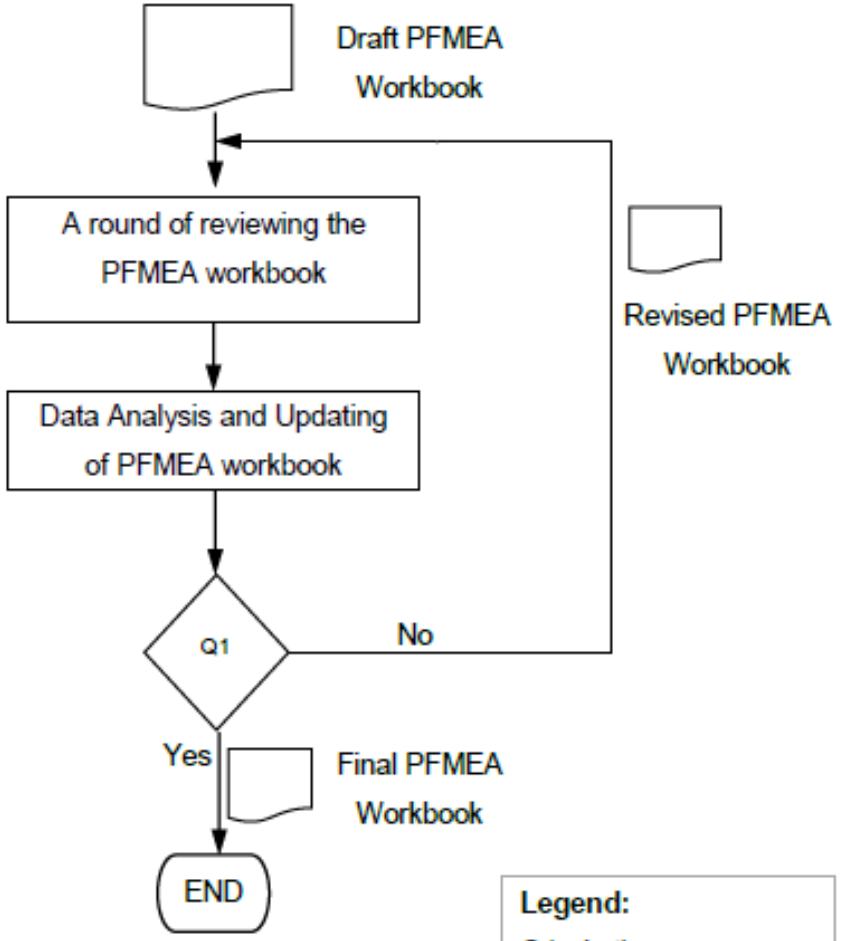
Process Failure Mode and Effect Analysis (PFMEA)

- The PFMEA had sought to establish failures in the business processes, that resulted in the following **functional failures** of spare parts management:
  - ❑Unavailability of spare parts
  - ❑Proliferation of spare parts
  - ❑Poor quality of spare parts
  - ❑High inventory management costs

Process Failure Mode and Effect Analysis (PFMEA)

- Conventional descriptions and rankings from FMEA were used.
- The study looked at:
  - functions (business processes)
  - failure modes
  - **Effect** and the **severity** of the effect
  - **Cause** and the **frequency** of occurrence
  - **Control** and **detection**

PFMEA through the Delphi



SAAMA2019 CONFERENCE

PFMEA through the Delphi

- The following statistical parameters were observed after each Delphi round:
  - ❑Mean opinion - mean values
  - ❑Spread - semi-interquartile ranges (SIQR) and standard deviations,
  - ❑and agreement percentages (Cohen's Kappa values)
- The study was halted after three Delphi rounds, after observation of a decreasing spread and an increase in agreement percentages.

PFMEA through the Delphi

- The average opinions of the last Delphi round were taken as the final opinion of the participants.
- The significance of each failure mode was determined using the risk priority number (RPN):

$$RPN = Mean\ Severity \times Mean\ Occurrence \times Mean\ Detection$$

Results

Snapshot of results of the business process **‘maintenance data analysis’**

Failure Mode	Effect	Sev.	Causes	Freq.	Controls	Det.	Max RPN
Poor quality results from analysis	Use of wrong inventory control model	8.5	Poor maintenance records	7	Maintenance audit / Supervision	7.5	799
			Access to CMMS	9.4	None	10	
			Incompetence	3	Supervision	7.5	

Results

Rank	Business process	Prevalent failure mode	Causes	RPN
1	Maintenance data analysis	Poor quality results from analysis	Poor data; Competency; Access	799
2	Supply chain processes	Delays in spare parts deliveries	Poor contract management	722
3	Inventory model assignment	Wrong management strategies	Poor results from data analysis	672
4	Maintenance planning	Disproportionate maintenance instructions	Poor results from data analysis; Maintenance postponement	659
5	Store management	Delays in retrieval of spare parts	Poor storage	365
6	Maintenance execution	Poor handling of rotable spare parts	Competency; poor Supervision	150

Conclusions

- Rigorous analysis of Asset Management business processes in spare part management .
- Sources of inefficiency in the business processes established .
  - ❑inferior maintenance data analysis, low reliability of supply chains, and incorrect inventory classification.
  - ❑The causes of these failures were determined.

Conclusions

- The sources of inefficiency were classified according to their significance. The RPN was used.
- The research was thus successful in that it met its objectives. The following was added to the Asset Management body of knowledge:
  - ❑A prioritised list of sources of inefficiency in South African power stations spare part management
  - ❑A general process for the rigorous analysis of Asset Management business processes

Thank you.