Obsolescence Management the study of Power Utility in South Africa

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Abstract

Companies like power utilities are confronted by a challenge of ageing of plant systems and equipment. The impact of obsolescence in power utilities affects both the availability and reliability of the system. This paper is aimed at presenting the result of the research conducted within the South African power utility company on the subject of obsolescence management. The study used both qualitative and quantitative research to collect and analyse data. The result of the study indicated the deficiencies in the management of obsolescence within power utility. The lack of awareness and funding was cited as the primary challenge in the management of obsolescence within the power utility. The study recommends that obsolescence management should form part of the business strategy, reviewed and be audited like other business processes**.**

Keywords

Obsolescence, Obsolescence Management, Business processes, Maintenance Methods, Technology Obsolescence models.

1. Introduction

Companies like power utilities in South Africa are facing the challenge to cope with the business demand and the frustrations from ageing equipment. Due to the age and the technology used by power utility plants some of the systems, are no longer supported by the original equipment manufacturer (OEM). The literature [1-3], defined the process of asset deterioration without the support from the supplier as obsolescence. There is evidence [4, 5] suggesting that obsolescence has both financial and operational impact on the business performance. The literature further suggests that technological advancement also influence the process of obsolescence [6]. Other publications [7, 8] maintain that obsolesce should form part of the design phase of the product and talk about the business strategy. This research attempts to A) identify the method employed by the South African power utility company to manage asset deterioration, B) identify technology management strategy suitable for the South African power utility company, C) identify areas of improvement to optimise the impact of asset deterioration.

Furthermore, lack of foresight on obsolete critical power plant components, government and other interested groups intervene with lawful regulations and restrictions as a failure in compliance with environmental policies can lead to product obsolescence. The cost of repeated obsolescence intervention throughout the power plant systems exceeds the incremental cost associated with an obsolescence management strategy. The power industry has no control when a certain manufacturer decides to no longer support or fabricate components identical to the ones installed in power plants. Power Utilities incur unnecessary cost escalation due to plant shutdowns as a result of lack of spares or lack of a suitable replacement for an obsolete component.

Many Power Utilities systems are manufactured comparatively in low quantities compared to mass-produced items in the commercial world [2]. These systems are often very expensive, built with state of the art technology for their time, and may be used beyond the original lifespan originally predicted. Design lifetimes in military systems are often on the order of 10-20 years, but many systems are now used for 50 years [3] and more. Examples of such systems include Boilers and Turbines systems.

As these systems evolve through their lifecycle, components may be upgraded to improve capability or to extend the systems' mission or to compensate for design flaws that only became apparent after extensive use. Also, components may be required to be replaced because the system lifespan of the component or over time there could be a larger demand than what was expected for a lifetime or the planned manufacturing level for that component. This has resulted in the lack of an effective Power Utility project budget cost over-run, slip project deadlines, and high risk of exhausting power utility funds. There has been a great loss of returns, loan debts increase, project missing scheduled times, and this has a high probability to jeopardize Power Utilities credit rating The loss of revenue has a potential to cause Power Utilities financial unsustainability, as money will be wasted on the delayed projects. With no doubt, the demand for electricity in the country has tremendously increased, and this, therefore, calls for the reliable supply of electricity to be available hence reliable systems need to be available all the time.

2. Research Methodology

The research used multiple data collection approach with the aim of getting to the bottom of the issue impacting the concept of obsolescence in the South African power utility company. The method adopted for the current study includes survey questionnaires which include both close and open-end questions. Survey Monkey, the online survey tool was used mainly to collect primary data. The secondary data was collected from the company records, journal article and newspapers. The author aimed at collecting data from every participant working in the asset management department within the power utility. However, this goal was not achieved because not everybody has access to the computer by e-mail. As a result, the survey questionnaires were distributed to 50 respondents who had access to computers with the e-mail. The respondents also need to be working with the asset management environment to participant in the current study. Furthermore, the participants were participating voluntarily in the study without any forcing mechanism. The survey was distributed to the respondent two times.

The first request receives ten responses which are 20% of the total group. After two weeks the research team also sends the reminder to people who did not send the response back to assist by participating in the survey. The second request return with additional nine responses which was 18% of the original request. In total, the survey request received 19 useable responses which 38%. The respondent asked to disagree strongly, disagree, natural, agree, and strongly agree with the statement in the Likert scale items. The content and face validation were the main validation method for the research. The Cronbach’s Alpha was also instrumental in the calculation of the internal consistency of the Likert scale item. Triangulation was also one of the methods to ensure the reliability of the study, where the authors use the information from the primary source (Online survey) and secondary data (operational information from company records) to check the differences and similarities. The authors further use the Pearson correlation matrix to identify the item which has a negative correlation in the Likert scale item. The Chi-Square was also used to test the hypothesis. The relative importance index was also used to identify the gay on factors which were perceived as having the impact on the performance of the asset management strategy.

3. Results

A. Demographic

This section presents the features of the respondents of the study. Table: 1. below show the age distribution of the respondents. From the number of 19 members who responded to this question, only 18 members answered this question. The majority (50%) of the respondents has the age ranging from 30-35 years old of age. The result shows that majority of the respondents are just getting out of the youth stage of their life

Table 1. Age Distribution

Answer Choices	*Responses*	*Responses (%)*
30-35 years	9	50%
35 - 40 years	3	17%
45 - 50 years	2	11%
25-30 years	2	11%
More than 50 years	1	6%
40-45 years	1	6%
20-25 years	0	0%
15- 20 years	0	0%

Answer Choices	***Responses***	***Responses (%)***
TOTAL	18	100%

The participants were also asked to indicate their number of experience within engineering environment or working with engineering asset. Fig.1 below indicate that majority (54%) of the respondents has experience ranging from 5-10 years of experience in the engineering environment. The result in Fig.1 suggests that the respondents had the fair understanding of the subject.

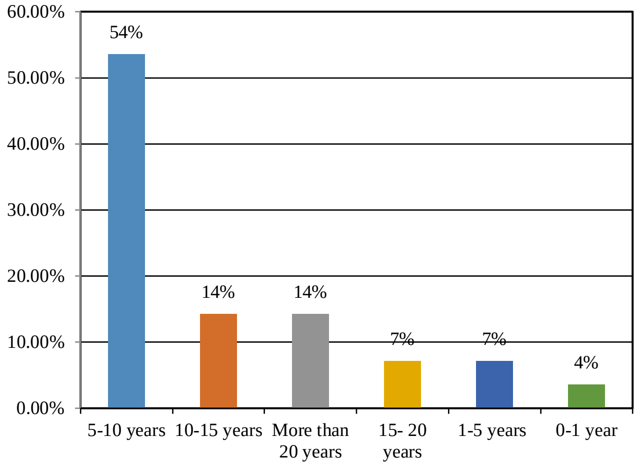

Figure 1: Experience

The respondents were also asked to indicate their level of responsibility. Table 2.below shows that majority (39%) of the respondents carries the title of the engineer. Majority 28% of the respondent classified themselves as senior engineers. The result shows that majority of the respondents had the understanding of the subject due to their role and responsibilities.

Table 2: Level of responsibility

Answer Choices	***Responses***	***Responses (%)***
Engineer	7	39%
Senior Engineer	5	28%
Engineering Manager	3	17%
Chief Engineer	1	6%
Other	1	6%
Senior Technologist	1	6%
Artisan	0	0%
Engineering Technician	0	0%
Principal Engineer	0	0%
Technologist	0	0%
TOTAL	18	100%

B. The effectiveness of the obsolescence management

This section presents perceptions from power utilities' employees regarding the quality of obsolescence management strategy. The researcher used the hypothesis; 'the power utility has a good obsolescence management strategy'. To test this hypothesis, the researcher used the Likert scale and the Chi-Square test [9]. The respondents were asked to rate the items from strongly disagree, disagree, neutral, agree, and strongly agree on the Likert scale. The Likert scale items were deducted from the literature from databases like UJoogle and Google scholar. Table 4. below shows the eight elements of the good obsolescence management strategy. The literature search was limited to English papers and the author followed a narrative literature review to deduct the themes. The internal consistency of the items was tested using the Pearson Correlation and the Cronbach Alpha.

Table 3 below shows the Pearson correlation matrix for the Likert scale items in table 4. Some items (Q1, Q3, and Q4) indicated the negative relation within the scale. The scale has the total internal consistency or Cronbach Alpha of 0.83. Uma and Roger [10, 11] suggested that the acceptable internal consistency should start from 0.6 upward. The literature further suggests that the item with the negative relationship affects the internal consistency of the scale and should be removed [11]. In the current research because the internal consistency is 0.83 which is higher than 0.6 recommended by the literature the author did not see the need to remove the item (Q1, Q3, and Q4).

Table 3. Age Distribution

	Q1	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*
Q1	1							
Q2	0.75	1.00						
Q3	0.64	0.15	1.00					
Q4	-0.09	0.56	-0.68	1.00				
Q5	0.66	0.95	0.18	0.49	1.00			
Q6	0.51	0.89	0.04	0.56	0.98	1.00		
Q7	0.78	0.98	0.15	0.48	0.95	0.89	1.00	
Q8	0.37	0.82	-0.05	0.61	0.94	0.99	0.81	1.00

The Cronbach Alpha of 0.83 further shows that majority of the item within the scale complement each other. The further shows the good reliability of the study [10]. Table 4 is the perceptions about the quality of obsolescence management strategy based on the eight factors deducted from the literature. Fig.2. below shows the relative importance index (RII) of the eight-item used to assess the quality of obsolescence management strategy.

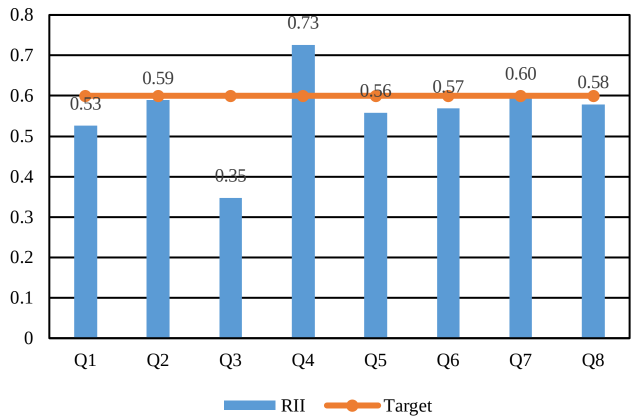

Figure 2: Relative important index

The main purpose of using the RII was to identify the areas of improvement or the gap in the system. Onatere-Ubrurhe [1] suggested that the RII of the system should be at least 0.6 or above. RII less than 0.6 indicates the need for improvement.

Table 4. Perception of the quality of obsolescence

Items	***ID***	***Strongly disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly agree***	***Sample size***	***Weighting***	***Mean***	***RII***
		1	***2***	***3***	***4***	***5***	***Total***	***W***	***M***	
There is independent team responsible for obsolescence management.	Q1	1	10	4	3	1	19	50	2,63	0,53
		5%	53%	21%	16%	5%	100%			
There is a separate policy for Obsolescence management.	Q2	1	6	6	5	1	19	56	2,95	0,59
		5%	32%	32%	26%	5%	100%			
There are regular workshops to create awareness about the role	Q3	7	10	2	0	0	19	33	1,74	0,35
		37%	53%	11%	0%	0%	100%			

of obsolescence management processes.										
The obsolescence management as part of the asset management strategy.	Q4	0	1	7	9	2	19	69	3,63	0,73
		0%	5%	37%	47%	11%	100%			
The current obsolescence management strategy supports the business objectives.	Q5	1	6	8	4	0	19	53	2,79	0,56
		5%	32%	42%	21%	0%	100%			
Senior Management fully supports the current obsolescence management practice.	Q6	1	5	9	4	0	19	54	2,84	0,57
		5%	26%	47%	21%	0%	100%			
Obsolescence procedures are easy to understand.	Q7	0	6	6	4	1	17	51	3,00	0,60
		0%	35%	35%	24%	6%	100%			
Obsolescence documents are easy to understand.	Q8	2	4	8	4	1	19	55	2,89	0,58
		11%	21%	42%	21%	5%	100%			

The result in table 4 and Fig. 2 show that the lack of awareness (RII =0.35) is one area, which needs urgent attention within the power utility environment to reduce the impact of obsolescence. The respondents also indicate the formulation of teams which will be responsible for obsolescence management as the second area which needs attention with the (RII = 0.53). The respondents also highlighted the strategic alignment between obsolescence and business strategy as the third area which needs attention. The respondents supported the existing asset management strategy (RII= 0.73) to cater to obsolescence.

C. Perceived challenges affective obsolescence management

The respondents were also requested to comment on the issues affecting obsolescence management. Fig.3. Shows the thematic codes which emerge during the qualitative data analysis from the text. This section of the survey allowed the participants to express their view on the issues affecting the management of the asset deterioration. The lack of awareness also tops the list from the feedback provided by the participants. Some of the suggestions from the respondents include *"Engineers do not understand the maintenance to prolong the life of the plant. This is a serious challenge in Eskom. It is not transparent to what is in place or who is responsible. I get the effect that it is more ad-hoc regarding communications to strategy to be implemented."* The respondents also indicated that power utility is reactive in addressing obsolescence challenges. The suggestion from the respondents *"Rate of current technology obsolescence is high. Newer technologies become obsolete faster than before requiring continuous upgrades becoming an endless cycle of costly replacements. The current procedure takes too long, this can result and plants failing before a new project can be conducted*

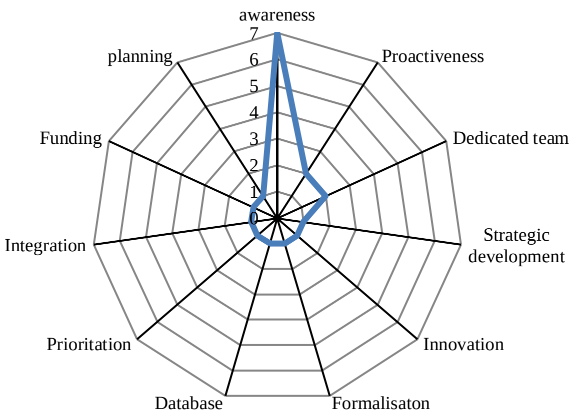

Figure: Thematic codes

D. Hypothesis Testing

The author continued to test the hypothesis by proving the null hypothesis and alternative hypothesis

Step 1: State the Hypothesis
Null hypothesis (H_0): The existing obsolescence management strategy supports the South African Power Utility business objectives.
Alternative hypothesis (H_1): The existing obsolescence management strategy does not support the South African Power Utility business objectives.
Step 2: Select a level of significance (α) and Degree of Free (Df) calculations
From Minitab statistic software, the level of significance was selected to be $\alpha = 0.05$, and from the calculations, the Degree of Freedom was found to be Df = 7. The Chi-square distribution for this study is indicated in the figure below.

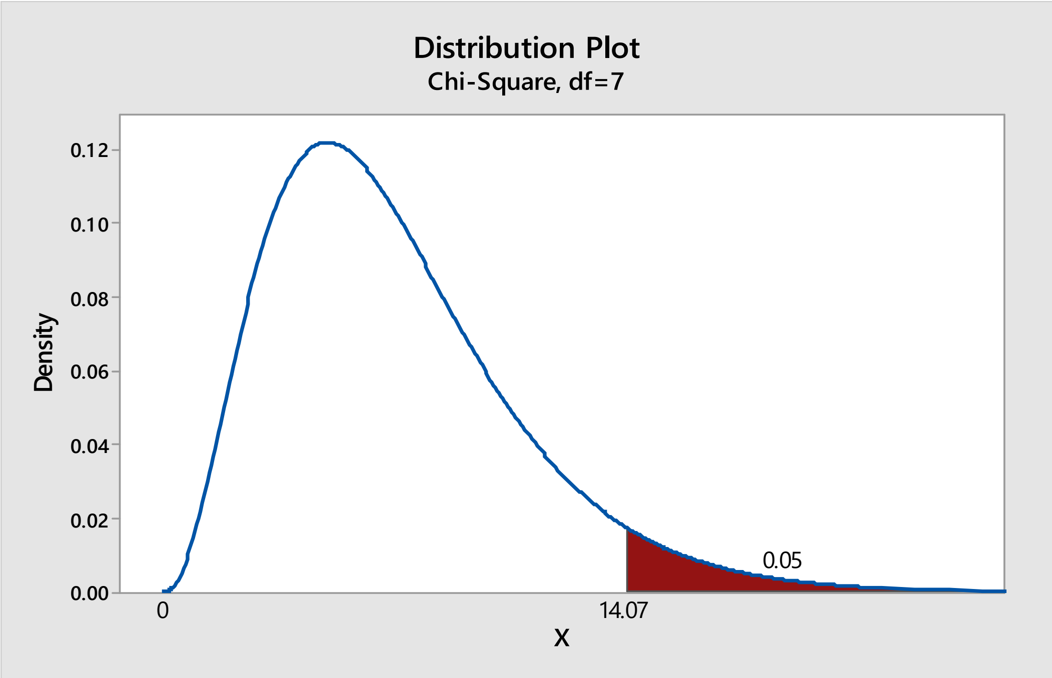

Figure 1: Chi-Squared Distribution

Step 3: Derive Expected values from the observed values
Table 5: below indicates the observed values for disagreement with the Likert scale items and agreements. The scale consisted of strongly disagree, disagree, neutral, agree and strongly agree. For the hypothesis test, the strongly disagree and disagree were combined as indicated in the table below. The author also combined 'agree' and 'strongly agree' into one agreed values as indicated below. The neutral was not included in the calculation.

Table 5: Chi Square (X2) Test Observed Values

Observed Values									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	**Total**
DISAGREE	11	7	17	1	7	6	6	6	**61**
AGREE	4	6	0	11	4	4	5	5	**39**
Totals	15	13	17	12	11	10	11	11	**100**

As indicated in table 5 the scale had a total of 61 disagreements and 39 agreements with the Likert scale items. Q1 had the total of 15 people who selected 11 disagree and 4 who selected agree. In the above table 5, disagreement with the Likert scale was dominating except Q4 where the majority (11) of the people selected agreement with the Likert items.

Table 2: Chi Square (X2) Expected Values

Expected									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	**Total**
DISAGREE	9.15	7.93	10.37	7.32	6.71	6.1	6.71	6.71	
AGREE	5.85	5.07	6.63	4.68	4.29	3.9	4.29	4.29	

The table above shows the expected value derived from the observed values in table 6 and the values in table 7 were calculated using Minitab Statically software. The above figures are critical in the calculation of Chi-square (X^2).

Table 3: Chi Square (X^2)statistical test

DISAGREE Chi Square	0.37	0.11	4.24	5.46	0.01	0.00	0.08	0.08	
AGREE Chi Square	0.59	0.17	6.63	8.53	0.02	0.00	0.12	0.12	
Total Chi Square)	**0.96**	**0.28**	**10.87**	**13.99**	**0.03**	**0.00**	**0.19**	**0.19**	**26.52**

The values from Table 8 above were derived from the formula

Equation 1

$$X^2 = \sum \frac{(O-E)^2}{E}$$

X^2 = Chi Square Value
O = Observed values
E = expected values
And the $X^2 = 26.52 > \text{Critical Value} = 14.067$

Based on the calculation, the Chi-square value falls in the rejection region or it is greater than the critical value. If the Chi-square is greater than the critical value, the null hypothesis is rejected, and the alternative hypothesis is accepted.

E. Power Utility Statistics from asset management systems

This section presents failure history patterns of Power Utility systems from the asset management system from year 2014 to 2016.

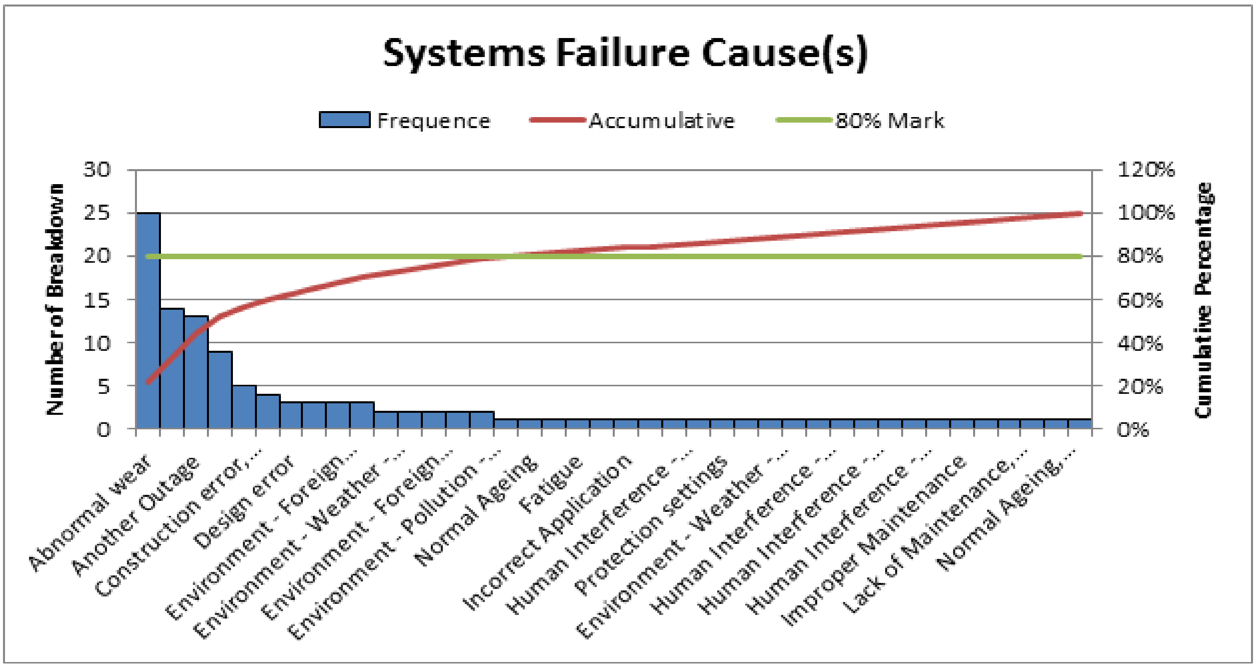

Figure 4: System Failure Causes

Figure 4 above projects the frequency of failures from the past years from the Power Utility systems [29]. X axis projects number of breakdowns and Y axis shows percentage of failures over the years. The graph presents what was the cause of those failures during the last 3 years for the Power Utility. The power Utility experienced 124 failures in the last 3 years. The highest risk of failures was due to abnormal wear and tear, error on designs, construction errors, environmental failures, human interference, lack of maintenance and ageing. Therefore it is clear that during the years (2014-2016), the breakdowns and causes of failures were due to a number of factors relating to wear and tear. Ageing was also one of the causes of failures.

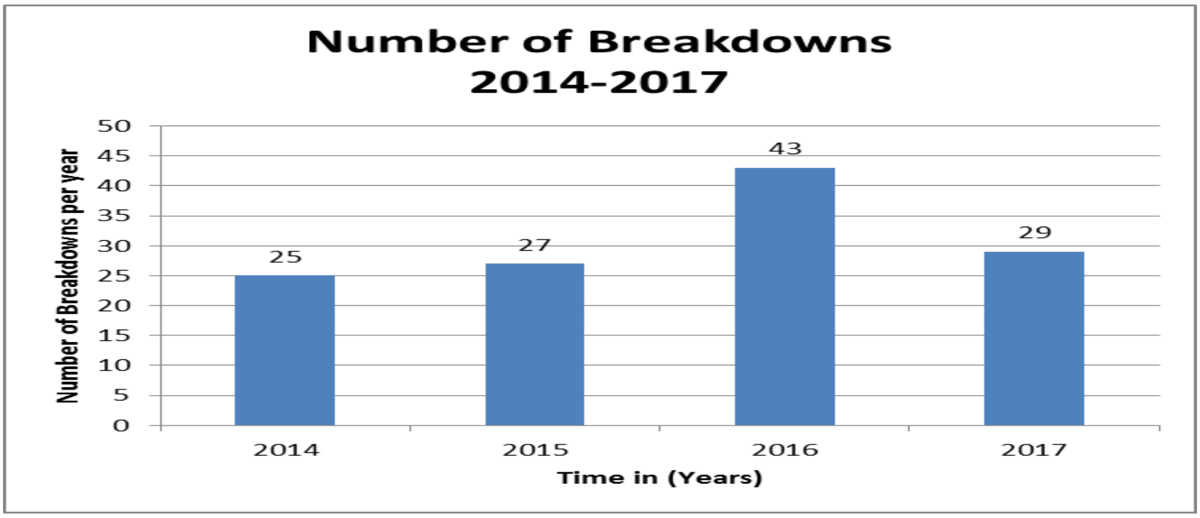

Figure 5: Number of Breakdowns – (X-axis number of breakdowns in %, Y-axis number of years

Figure 5 projects the frequency of breakdowns from the past 3 years from the Power Utility systems. X axis projects number of breakdowns (%) of failures five years and Y axis projects numbers of years. The graph represents the highest rate of failures at 29% in 2016, followed by year 2015 where failures were around 18%. In 2014, 17% of failures were recorded with the lowest percentage of 15% in 2017, and as projected 20% would be expected end of 2017. Total numbers of 124 failures were experienced over the last 3 years by power utility.

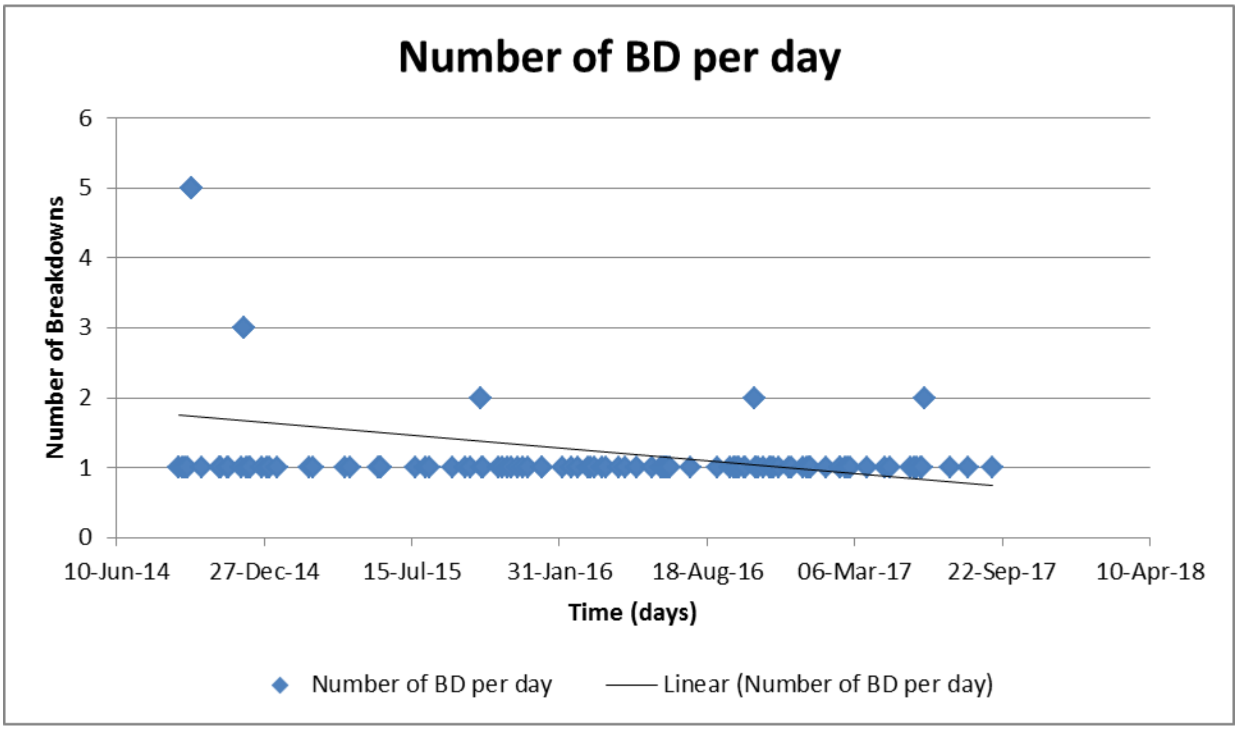

Figure 6: Number of breakdowns per day

Figure 6 shows a projection of breakdown of failures per day, as from June 2014 - December 2014 the failures were close to two breakdowns in those months of that year. In July 2015 the breakdowns came down a bit, but from January 2016- August 2016 there was also a slight improvement of breakdown as indicated on the graph. Between March 2017 and September 2017, there was a drastic improvement. Therefore, from the graph, the highest breakdowns were happening in year 2014.

The organisation appears to be experiencing these failures in the last 5years. Although these failures were recorded during this period, continuous maintenance on the power plants was still happening and most of the equipment was working well. Despite the observable trend of failures, the above graph shows a gradual decrease in failures.

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Biographies

Nomatshawe Gantsho is currently employed at Eskom as a Design Engineering Manager in Group Technology Division. She has a B-tech Degree in Electrical Engineering from Tshwane University of Technology, She is currently finalizing her M-Phil in Engineering Management at University of Johannesburg. Prior to her current position she spent 10 years working as a Senior Engineer in Control and Instrumentation at Eskom. She is a registered professional engineer (Pr Eng) with the ECSA. Her research interests cover Technology Obsolescence Management, Technology Obsolescence models and aligning technology obsolescence with business process and strategies

Bheki Makhanya is currently a full time doctoral student at University of Johannesburg. He earned MPhil. in Engineering Management all from the University of Johannesburg, South Africa. He has about 10 years' experience working in rail industry, where he started working as project manager and currently employed as senior maintenance manager for rolling stock (wagons and locomotives). His research interests include project management, maintenance and reliability management.

Prof JHC Pretorius is currently the Head of Postgraduate School of Engineering Management. He has earned a Bsc Hons in Electro-technics, MEng in Electrical and Electronics Engineering, MSc (Pulsed power and Laser Physics), Ding (Electrical and Electronics Engineering). He have over 30 years of lecturing experience and consulting with various utilizes on optimization of their electrical systems.

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