PAM Asset Key Performance Indicators Module

Introduction

The Asset Key Performance Indicators (KPIs) module uses empirical analysis of the asset maintenance and failure data, and other data to present important KPIs for assessing asset performance. Three KPIs are presented:

- The terminal events KPI presents a range of metrics associated with reactive interventions and asset failure.
- The early asset failures KPI identifies assets that failed shortly after the warranty period.
- The asset graveyard risk KPI identifies assets that are classified as being in use and therefore on the balance sheet but which may have been abandoned and are therefore no longer in use.

All the results in this paper are for clean water and waste water pumps.

Input and Output Files

The input file to the module is the output file from the Time to Failure Transformations module, and the output is graphs and tables of the KPIs that are accessed from the module's visualisation component.

Terminal Events KPI

Terminal events and non-terminal events are defined and described in *Time to Transformations Module* in PAM Modules.

The terminal events KPI analyses the number and cost of asset failures, asset downtimes and the times between reactive interventions and failures by a range of asset and location factors, and other classifications. The deseasonalised dynamic variation of asset failure by day and by week, and the effect of extreme events on asset failure can also be presented. Furthermore, the effect of the most recent intervention type on the time since the previous terminal event can be analysed.

Figures 1 and 2 show how the time to the next terminal event depends on the number of previous terminal events, and the number of non-terminal events since the most recent terminal event respectively.

Figure 1

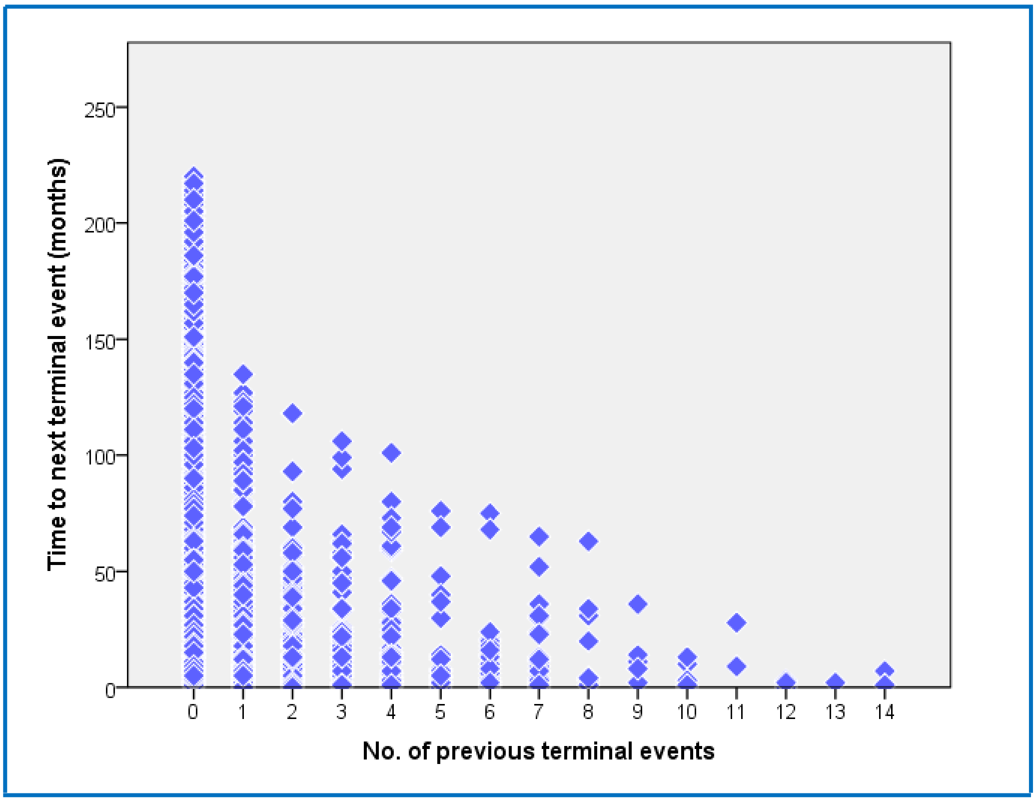


Figure 2

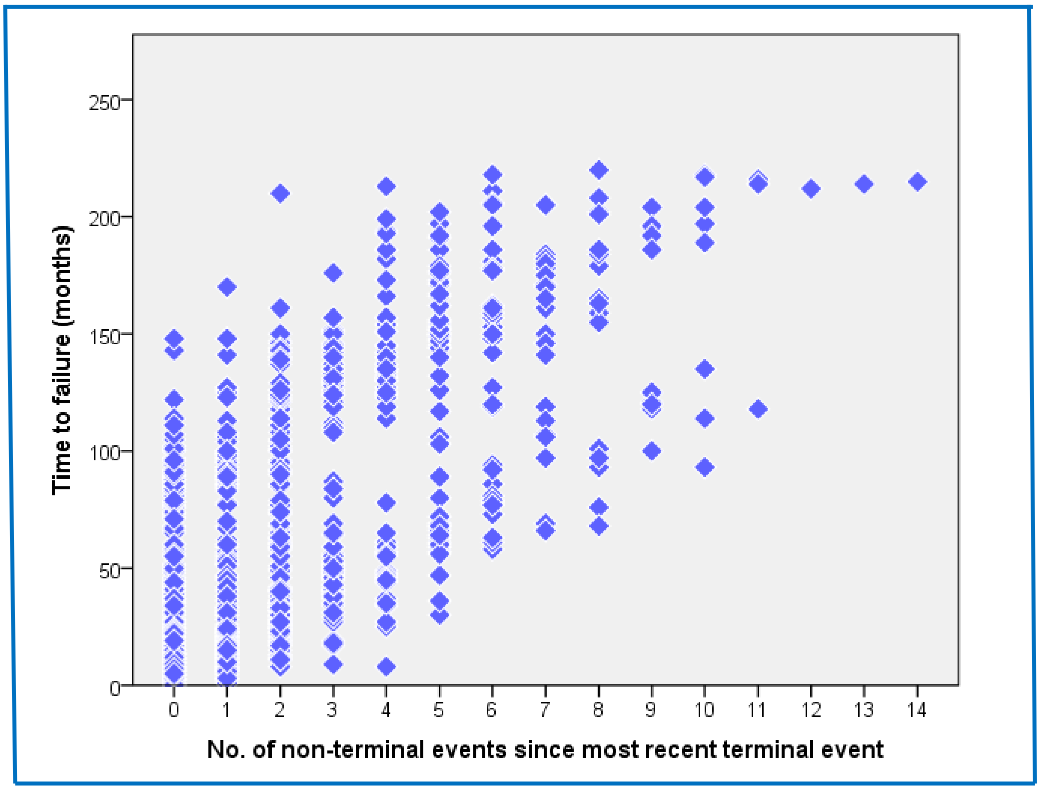


Figure 1 shows that the time to the next terminal event decreases as the number of previous terminal events increases, and Figure 2 shows that it increases as the number of non-terminal events since the most recent terminal event increases. It is interesting to note that Figure 2 shows that the time to the next terminal event tends to a limit as the number of non-terminal events since the most recent terminal event increases. Thus, over-maintaining assets does not increase further the time to the next terminal event but it does increase the assets' maintenance costs.

Figure 3 shows the effect of the number of previous terminal events on the mean time since the previous terminal event for different types of the most recent intervention. Proactive non-terminal interventions (blue) increase the time to the next terminal event most and reactive terminal interventions (gold) increase it least. Another benefit of adopting a more proactive maintenance policy is the large reduction in cost that can be achieved compared to the cost of using a more reactive maintenance policy (this is discussed in detail in *Asset Survival Simulations Module* in PAM Modules).

Figure 3

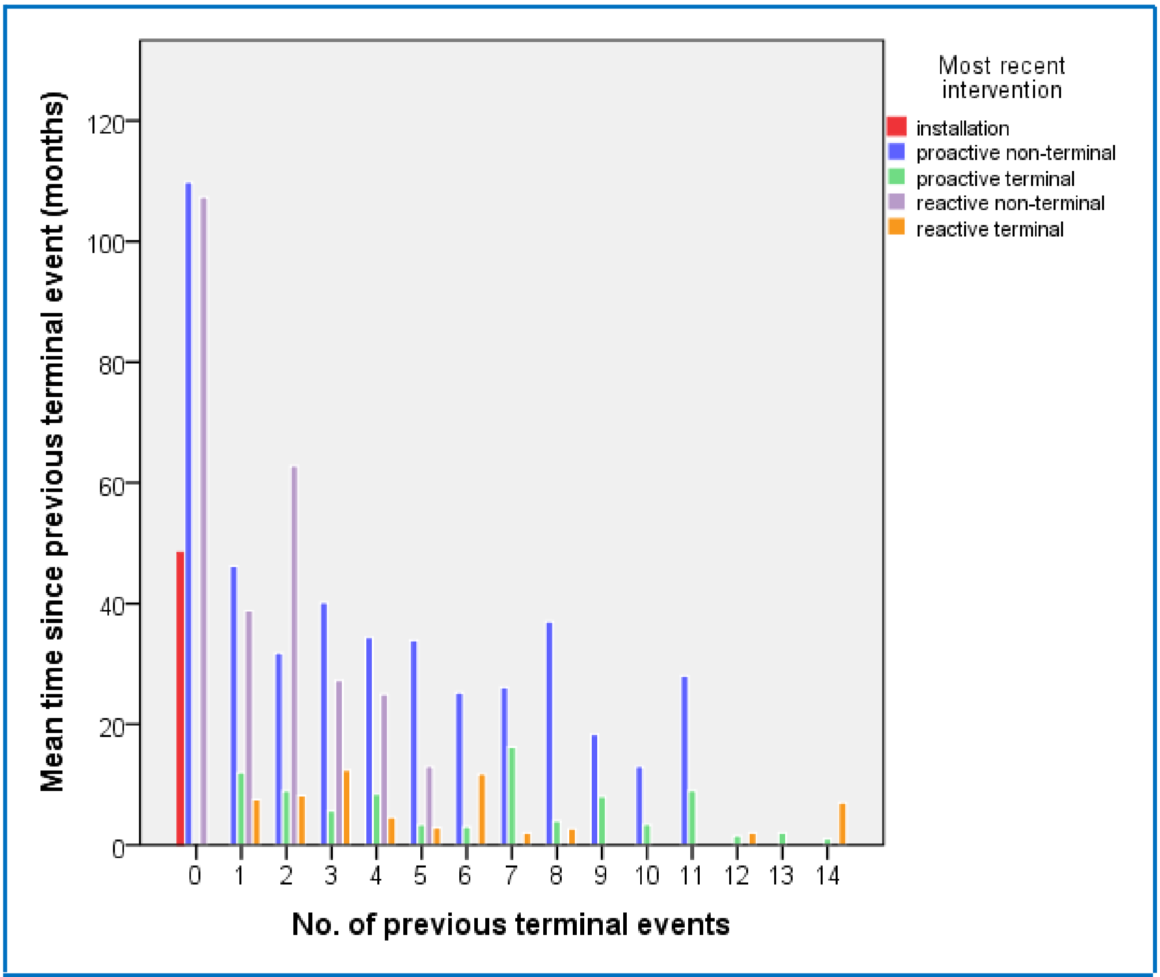
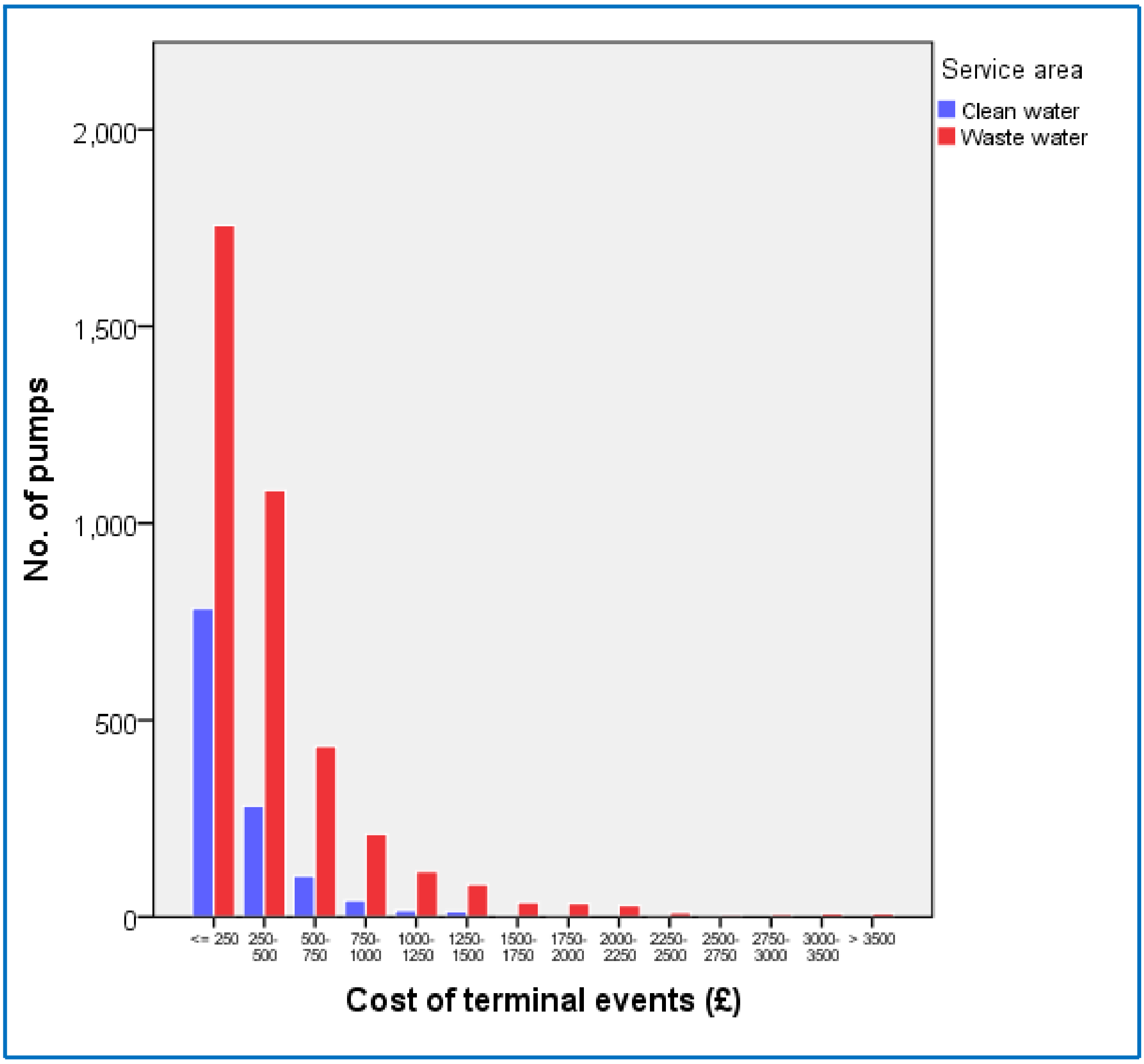


Figure 4 shows the distribution of the cost of the terminal events for clean water and waste water pumps. Clean water pumps have more of the least expensive (<= £250) terminal events than waste water pumps relative to their proportion in the sample (a third). For all other terminal event costs (> £250), waste water pumps are proportionately more common than clean water pumps. The maximum cost of the terminal events for clean water pumps is £2,530 and £9,200 for waste water pumps.

Figure 4



In addition to the cost of terminal events as shown in Figure 4 and the effects of different types of the most recent intervention on the mean time since the previous terminal event as shown in Figure 3, asset downtime is an important metric for assessing asset performance. Figure 5 shows the distribution of the cumulative percentage downtime when the pumps are ranked by increasing downtime percentage. The skewed distribution of the downtime percentage is clear.

Figure 5

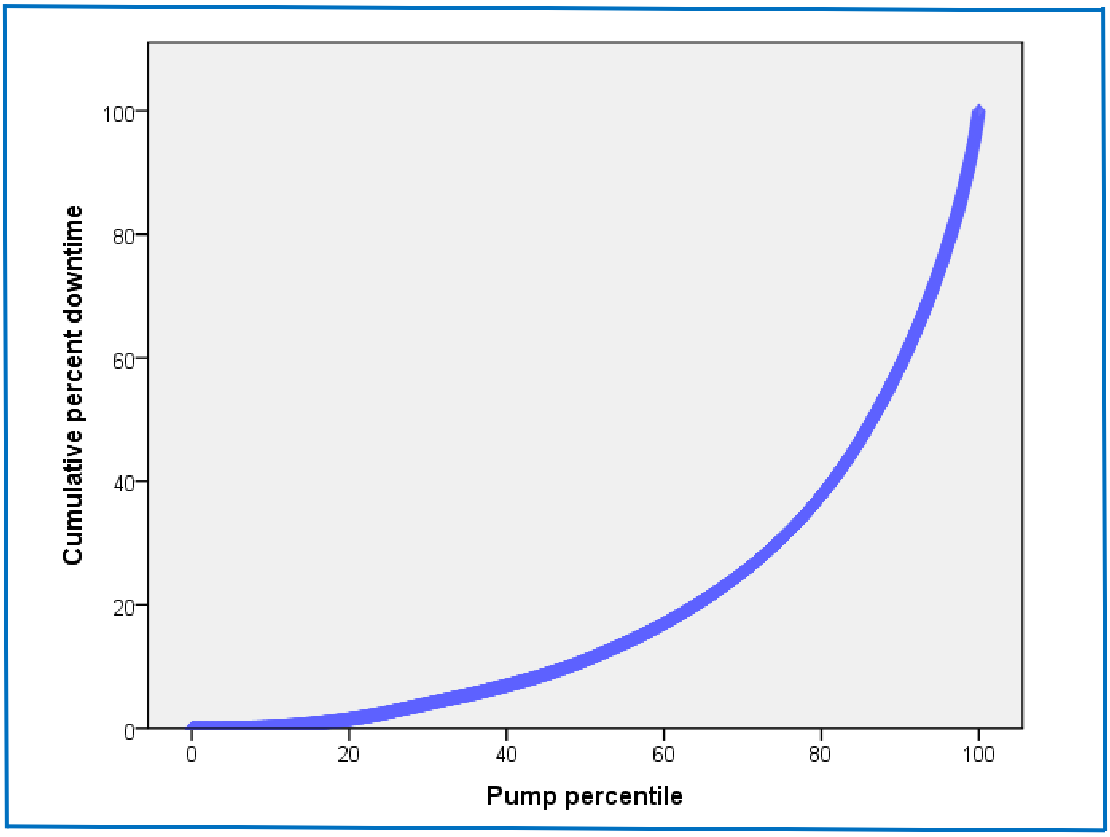


Table 1 shows the distribution of the pumps' downtime percentages for the worst 50% performing pumps. The best 50% performing pumps account for only 10.9% of the percentage total downtime and the worst 5% performing pumps account for 26.6% of the percentage total downtime. As with Figure 5, the table clearly shows the skewed distribution of the downtime percentage.

Table 1

Pump Percentile	Cumulative Percent Downtime
50	10.9
60	16.6
70	24.8
80	37.2
90	59.1
95	73.4
100	100.0

Early Asset Failures KPI

The early asset failures KPI identifies assets that suffered terminal events during a specified (short) period after the warranty period. The data in Figures 6 and 7 are for terminal events suffered by clean water and waste water pumps in the 36 months after the warranty period.

Figure 6 shows the distribution of the number of terminal events. The proportions of clean water pumps and waste water pumps that suffered at most three terminal events are the same as their proportions in the sample for each number of terminal events (1/4:3/4). However, waste water pumps are more likely to suffer at least four terminal events than clean water pumps.

Figure 6

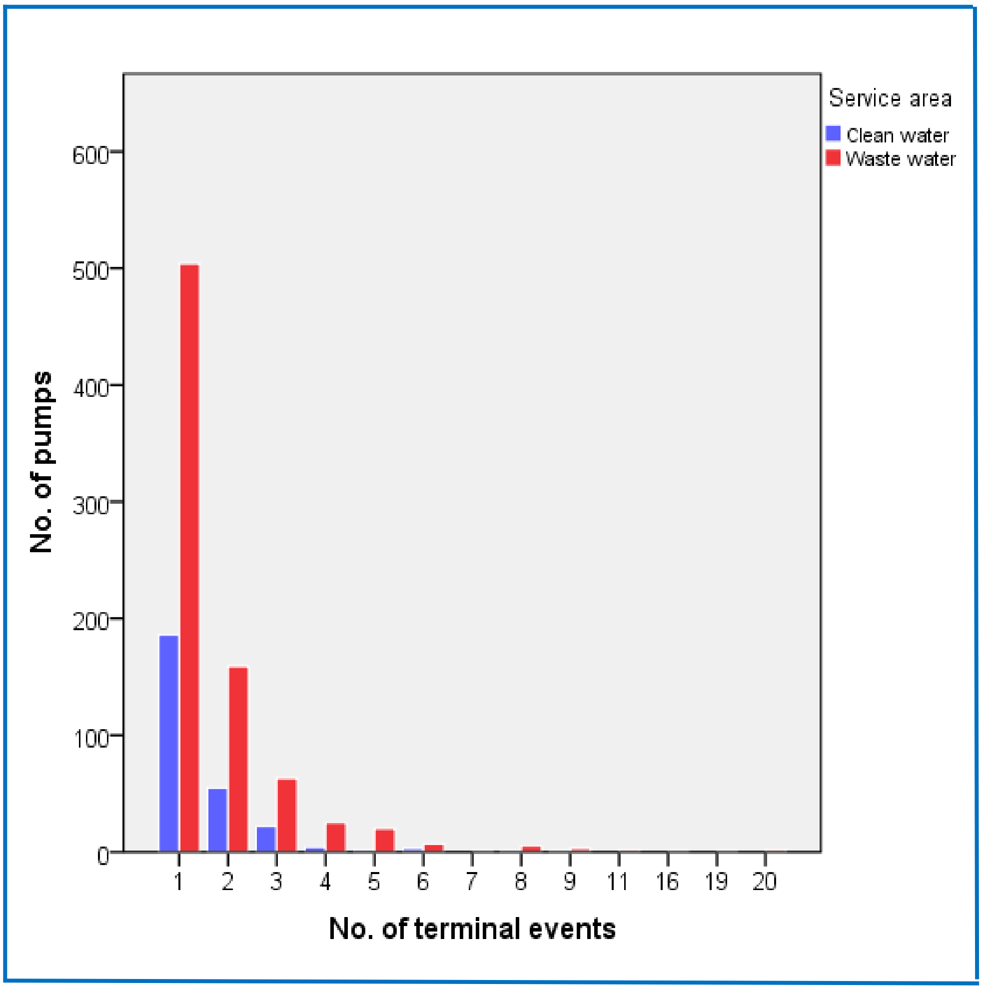
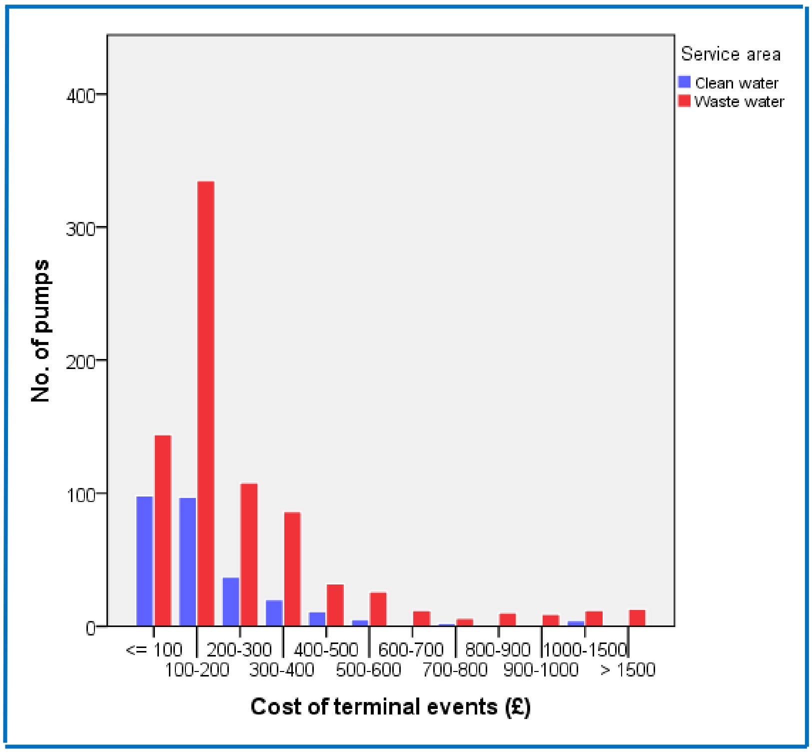


Figure 7 shows the distribution of the cost of the terminal events. Proportionately (>=1/3), the clean water pumps had more of the least expensive (<=£100) terminal events than the waste water pumps. For all other terminal event costs (>£100), waste water pumps are proportionately more common.

Figure 7



Asset Graveyard Risk KPI

The asset graveyard risk KPI identifies assets that are classified as being in use and therefore on the balance sheet but which may have been abandoned and are therefore no longer in use. The graveyard risk of an asset is the time since its most recent maintenance.

There are two reasons why an asset can have a high graveyard risk.

- It is in use but has not had maintenance for a long time. In this case, it should have a maintenance intervention and the maintenance history database then updated.
- If the site has been abandoned and the asset not had maintenance for a long time, the asset may still be in working order. In this case, the asset can be recovered, given a maintenance intervention and moved to a new site. On the other hand, it may be in such a poor state that it cannot be refurbished and so must be disposed of. In both cases, the asset register and maintenance history database must be updated.

Figure 8 shows the distribution of the pumps' graveyard risks in months. The tail of the histogram is flat rather than a continuation of the decay, suggesting that the pumps in this area form a distinct group and should be investigated to find out why they have not had maintenance for a long time.

Figure 8

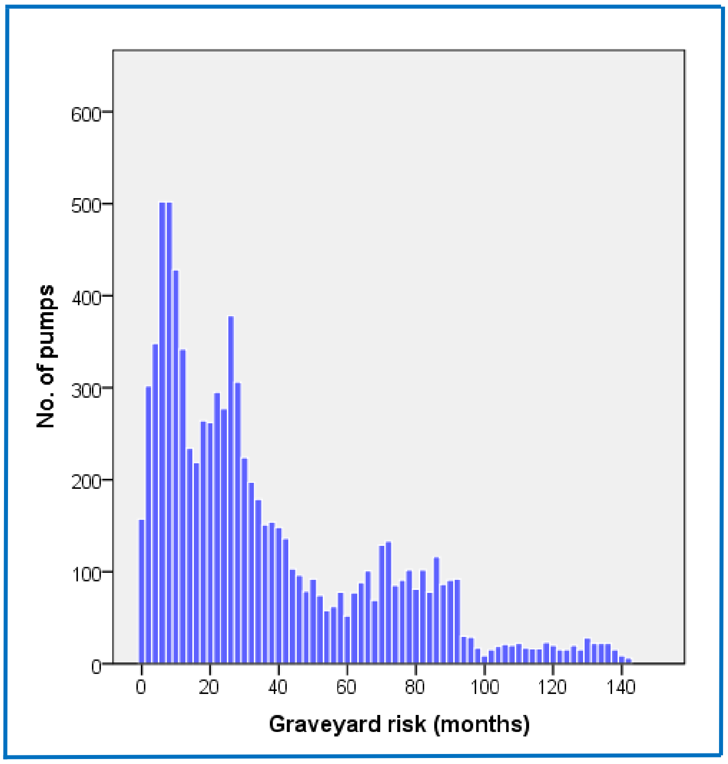


Figure 9 shows the distribution of the graveyard risk in years of pumps in sites that are in use and pumps in sites that have been abandoned. As expected, the graveyard risks of the few pumps in sites that have been abandoned tend to be larger than the graveyard risks of pumps in sites that are in use.

Figure 9