

DATA VISUALISATION – THE NEW CURRENCY OF THE WATER INDUSTRY

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ABSTRACT: *Understanding business performance is paramount to achieving a sense of ownership. Managing by evidence and fact, being honest and straightforward about performance is the only way the water industry will gain support from customers and stakeholders both internal and external. TasWater is continuously embracing digital technologies. It is systematically improving data collection and the interconnection of data sources to derive evidence based, defensible decision making and business optimisation. Not only does the resulting knowledge base support TasWater engineers but it provides a reliable point of reference for community engagement and communications staff, ensuring that all elements of the business can speak in a consistent, authoritative and transparent manner.*

KEYWORDS: asset performance, business performance, insights, business objectives, optimisation, risk mitigation, productivity Improvement, unlocking data, lifecycle decision making, prudence, fact based.

1 Introduction

This work is driven by the need for all stakeholders in TasWater to understand the impact they have on delivering business objectives. Understanding business performance is paramount to achieving a sense of ownership. Managing by evidence and fact, being honest and straightforward about performance is the only way the water industry will gain support from customers and stakeholders both internal and external.

The business insights data visualisation work at TasWater and presented here as case studies are focused on infrastructure asset performance metrics however better visualising other data sets such as performance against corporate plan KPIs will assist Taswater in building business knowledge and understanding of impacts against the delivery of corporate objectives.

Through business insights TasWater seeks to drive:

- Productivity and optimisation;
- Understand and reduce risk through system knowledge;
- Better communicate business performance knowledge;
- Remove ambiguity; and
- Develop reporting capabilities.

The case studies completed at TasWater have begun and continue to break down silos by ensuring we all talk a common language,

improved efficiency, productivity and clarity of purpose throughout TasWater.

YEAR CASE STUDY WAS IMPLEMENTED
2016 to 2017 (ongoing)

2 Case Study Summary

TasWater is continuously embracing digital technologies. It is systematically improving data collection and the interconnection of data sources to derive evidence based, defensible decision making and business optimisation. Not only does the resulting knowledge base support TasWater engineers but it provides a reliable point of reference for community engagement and communications staff, ensuring that all elements of the business can speak in a consistent, authoritative and transparent manner.

The main elements of the data visualisation methodology are:

- Defining the need for data visualisation and intended uses;
- Identifying the mechanism for data visualisation;
- Rapid prototyping and refinement of data dashboards;
- Application to decision making; and
- Identifying lessons learned

Implementation of business insight visualisations to date has assisted in:

- Identifying capital projects not included in TasWater's current capital program but causing concern to customers;

- Reduction in unnecessary planned maintenance being performed against low criticality assets;
- Identification of critical assets under maintained posing a high risk to TasWater's service delivery;
- Communication within all departments of poorly performing assets impacting TasWater's customer experience; and
- Providing one source of truth to understand current performance and the effect business activities have on the performance.

To demonstrate these stages in practice, case studies of asset performance data visualisation for Sewage Pump Stations, Gravity Sewer Networks and Water Networks are described. The paper will present TasWater's methodology for business wide data visualisation and performance data engagement.

3 Case Study Detail

Everyone within TasWater, from plumbers, to engineers, to the CEO and Board, need to understand the impact they have on delivering business objectives. Understanding business performance is paramount to achieving a sense of ownership. Managing by evidence and fact, being honest and straightforward about performance is the only way the water industry will gain support from customers and stakeholders both internal and external.

Data is the new currency of the Water Industry and we must ensure we are investing and deriving value which best delivers on our corporate objectives. TasWater, being a relatively new business, has the ability to approach data capture and visualisation in an agile manner, providing detailed insights to engage and empower the work force. In addition to providing insights within our business, we are continually seeking to provide transparency of our actions within the wider community.

Through business insights TasWater seeks to drive:

- Productivity and optimisation;
- Understand and reduce risk through system knowledge;
- Better communicate business performance knowledge;
- Remove ambiguity; and

- Develop reporting capabilities.

Since formation in 2013, TasWater, as all water utilities do, had many legacy systems providing data to the business in different ways. Due to the widespread structure and variation in quality of data, providing meaningful insights to business performance was challenging. This led to ambiguity and hampered our understanding of the business's true performance against National Performance Reporting (NPR) indicators, regulatory requirements, customer promises and basic asset management performance requirements.

In January 2017, after 18 months of preparation, design and thorough consultation, TasWater implemented a key strategic objective of its second regulatory period. The implementation of Maximo, an industry leading, all encompassing, asset management information system to support the improvements in the "way we work" and to drive towards ISO55000 Asset management certification. The movement of all areas of TasWater to a centralised platform with consistent data structures and rules has been the key to providing a pathway to development of insights into our performance.

While TasWater's third regulatory pricing and servicing period comes into effect in July 2018, the business is shifting its focus to driving sustainable operational savings through embedment of asset management principles and improved understanding of infrastructure performance. Being able to effectively visualise the performance, the impact of interventions that we make against our assets and the time to impacts being observed is key to ensuring we are acting prudently and efficiently.

3.1 Methodology for Data Visualisation

3.1.2 Defining the Need for Data Visualisation and intended uses:

During early 2017, TasWater was developing the regulatory period submission, Pricing and Service Plan 3 (PSP3). The plan required TasWater to provide a capital program for all asset classes justified through fact and prudent asset management practices. While TasWater had an understanding of what our main issues were and where they were, the

challenge was to articulate in a manner that would show prudent investment of capital money. A particular requirement was to better understand the performance of our critical Sewage Pump Station (SPS) infrastructure.

As a first pass, a spreadsheet was developed showing corrective maintenance history with key overflow risk indicators to demonstrate why intervention was required. While offering some insight and decision support, this first pass proved to be convoluted and computer processor power intensive. Through the creation of this initial concept, it was identified that TasWater had a need to make this information consistent, repeatable and accessible to all areas of the business. It needed to be expanded to allow all of TasWater's asset class champions to better engage and utilise TasWater's new asset information system. Thus the Data Visualisation project was born.

The project started with the objective statement,

“To provide consistent, repeatable and accessible insights to the performance of TasWater's Assets”

It is imperative that the objectives and outcomes are at the forefront of any visualisation. This becomes increasingly important where a business is endeavouring to develop insights into the way they work. The stakeholders involved must have a good understanding of what is important to the business, what they would like to see and how the information presented can highlight customer impacts for areas of investigation.

Upon understanding of the objective, the following questions were required to be asked for every visualisation to be developed to ensure the outcomes were achieved.

These following questions are crucial to solicit requirements for any visualisation:

- Why do we need to report the performance?
- What is the visualisation going to be used for?
- What are our goals?; and
- Who is the audience for the information?

3.2 Identifying the Data Visualisation Mechanism

Once the need is defined, the mechanism must be considered. Often the mechanism of how the data is accessed and presented can be the most difficult part of a data visualisation project. For implementation of TasWater's Data Visualisation project, four key mechanisms were defined:

- How to access the data;
- How to visualise the data;
- How will the information be made accessible and shared?; and
- The information driving the visualisation must update without manual intervention.

The first mechanism to be resolved was access to the data. In order to effectively engage with TasWater's new Asset Management Information System (AMIS), a duplicate of the production environment was required to ensure there was no impact to the day-to-day activities of TasWater. The access and creation of this database was perhaps one of the most difficult parts of this project and required facilitation of extensive internal stakeholder discussions to address differing views on responsibility of development of data solutions. Based on these discussions, it was agreed to have asset management specialist knowledge develop the visualisations rather than try to articulate through constant feedback with an IT officer.

The second mechanism to be resolved was the software to be used to develop the visualisations. From the initial concept developed in early 2017, TasWater utilised Microsoft Excel as there was familiarity of the software to the business and it was easily accessible. However, as discussed, this came with its own limitations with respect to processing power and file size. In addition, the visualisations did not provide the functionality required. In order to alleviate these issues TasWater engaged in the use of another Microsoft program known as PowerPivot. While this solution reduced the burden with respect to file size and processing power it did not provide a clean, efficient view required for stakeholders to effectively engage. Research into PowerPivot yielded its replacement, PowerBI.

PowerBI, a Microsoft tool, is provided under the business's current licencing arrangements without any additional opex burden, it is simple

to use, and provides the insights and interactivity required to engage stakeholders.

The third mechanism to be resolved was, “how will the information be made accessible and shared?” This was again solved using the PowerBI platform. In addition to its desktop solution, PowerBI also provides a cloud based platform that allows developed reporting dashboards to be shared through web link to anyone within the business, if they have PowerBI or not.

The fourth mechanism, “The information driving the visualisation must update without manual intervention” is delivered through access to database level information through the duplicate production database of the new AMIS and TasWater’s legacy systems. Direct access to the database which updates daily allows for information to be pushed to dashboards updating them with new information as it becomes available.

With the access to this tool and pulling together large, disparate data sources TasWater is now able to simply and efficiently develop data dashboards.

3.3 Rapid Prototyping and Refinement of Data Dashboards

To begin the process, the asset performance management Team determined the key asset classes which were required to be actively managed. These aligned closely to TasWater’s current performance team structure and included:

- Water Mains and Connections
- Sewer Mains and Connections
- Sewage Pump Stations
- Water Pump Stations
- Water Treatment Plants;
- Sewage Treatment Plants; and
- A management performance overview.

While performance management is consistent, all asset classes have their own idiosyncrasies. For example, Water Mains and Sewer main performance are reported as part of the National Performance Reporting (NPR) framework, and therefore it is not worthwhile to develop new performance metrics.

For our sewage and water treatment plants, details at the site level provide only an indication of poor performance. Due to the complexity of these sites, it is important to drill

these down to a lower level. With TasWater’s new Asset Location Hierarchy developed within Maximo and the use of the mobile platform for work execution, we are able to better attribute work at the asset level and “rollup” performance reporting of those assets which make up a portion of the process train at the plant.

Sewage and water pump stations are able to provide an indication of their performance at the site level, currently capturing count of occurrence. While the AMIS solution allows for identification of an asset level, impacts to the customer are often not seen at these sites unless an end effect is realised. Such as a sewer overflow or loss of customer supply.

Small, focused workshops were held for each of the asset class incorporating the TasWater asset class champion and their direct manager who is responsible for the performance metrics. These whiteboarded sessions all followed the same structured approach detailed below:

1. Outline the objective statement
2. Determine the need for performance reporting?
3. What are our goals and who is our audience?
4. What are the key metrics?
5. How do we want to visualise these metrics?

An example of the outputs of the management performance overview workshop is shown in Figure 1 .

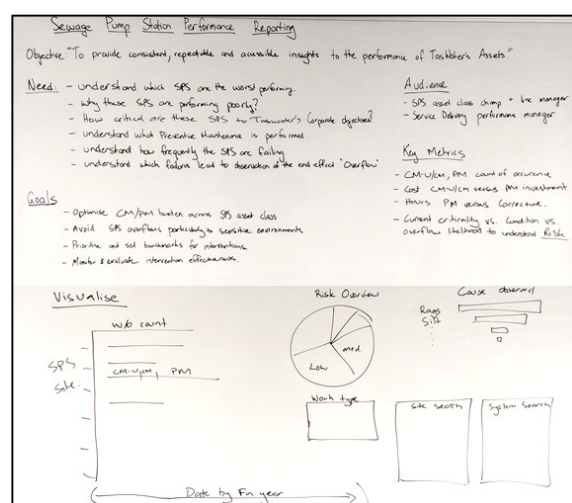


Figure 1: Sewage Pump Station (SPS) Performance Metrics Definition

Once the need and mechanisms were defined, and the workshop held, development of the initial dashboard visualisations occurred within the PowerBI platform. With the objective defined including consistency, it was important to ensure all asset classes observed performance in the same manner. This would allow any individual to understand the performance without having to try and understand how it was presented for each different asset class.

The resulting asset performance visualisations included the following key aspects:

For Water Network Performance:

- A8 overall able to be presented by suburb or system (A14 being the NPR Water mains breaks per 100km)
- Connections breaks per 1000 properties (Not currently an indicator)
- Customer service interruptions
- Repeat fail assets

For Sewer Network Asset Performance:

- A14 overall able to be presented by suburb or system (A14 being the NPR Sewer mains breaks and chokes per 100km)
- A15 overall able to be presented by suburb or system (A15 being the NPR indicator for Sewer Connections breaks and chokes per 1000 properties)
- Repeat fail assets

An additional function provided by PowerBI and TasWater's new AMIS solution is the ability to report fault location. With a dedicated integration with ESRI spatial, and with the correct data types and sources TasWater can now quickly, effortlessly create heat mapping visualisation of data driven by events on Maps. This becomes particularly important as it allow clustering of issues within the networks within a particular time period.

For Site based Infrastructure performance:

- Performance overview (Count of Occurrence split by Criticality or Risk Band, date of maintenance event and type of maintenance activity)
- Performance over time (A breakdown of all work types by any required date interval, be it year, quarter, month or even day)
- Failure overview (providing a detailed breakdown of the problems and causes for corrective events against

assets including operator failure remarks)

- Risk Overview (providing a detailed view of all sites or processes, their risk and criticality including a ranking with respect to exposure to business objectives); and
- Interrogation (providing detail of the top 10 sites or processes for corrective or preventive maintenance effort over a selected time period).

An overview of the SPS site based performance dashboard is shown below in Figure 2, centring on the Performance overview page. Sewer Networks Corrective work orders are presented in Figure 3 and Water Networks NPR performance presented in Figure 4.

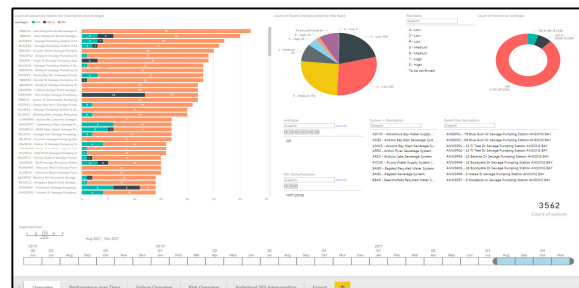


Figure 2: TasWater's SPS Performance Metrics Data Visualisation (Note multiple tabs to facilitate different visualisations)

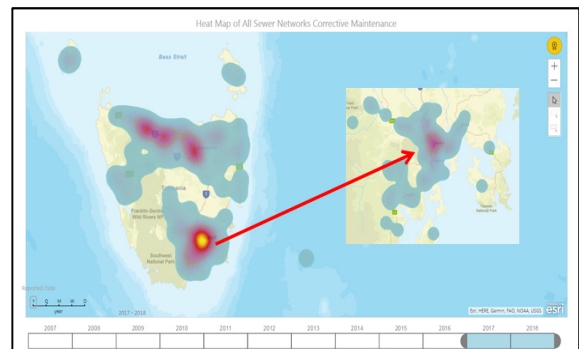


Figure 3: TasWater's Sewer Network Corrective Maintenance Heat Map Overview (State-wide, then centred to Hobart)

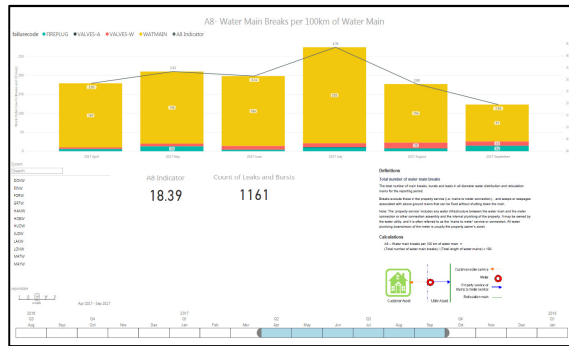


Figure 4: TasWater's NPR A8 Water Mains Breaks per 100km Overview with trend over time able to be summarised through a date heirarchy (Day-Month-Quarter-Year)

Once developed, all of the data visualisation dashboards were reviewed with the original workshop participants to ensure fitness for purpose. Consultation with the operational areas of the business began to provide feedback to operational staff as to the impact the work they are undertaking has on decision making for our business to assist in building a more cooperative business culture.

Key to the success of reporting from TasWater's perspective is the ability to interpret, easily understand and interact with data. As such, a visual solution which is intuitive to use, easy to learn and widely accessible is of utmost importance. As part of TasWater's collaboration suite, access to PowerBI is widely available and the interface is logical and simple to use with hierarchical drill down functions and many different visualisations.

3.4 Application to decision making - Preventive Maintenance Optimisation

With these visualisations developed it was imperative that value be driven from the efforts put in place. This being the optimisation of TasWater's assets to deliver on productivity and performance objectives.

Our first case study lies with Preventive maintenance optimisation (PMOP) undertaken as a result of TasWater's criticality framework. With the sewage pump stations in the North of Tasmania having their criticality assessed to TasWater's corporate objective, a number of assets were identified as being maintained above the requirement based on the consequence they pose to the business. A

total of 170 assets were reviewed and frequencies reduced to meet the requirements of the planned maintenance strategy.

While it was possible to perform the intervention, a means of reviewing the effectiveness of the intervention was required to ensure the implemented changes were yielding successful results. This is where data visualisations provided the answers. Figure 5 below provides the first pass of data visualisation of the interventions applied (augmentation of preventive maintenance frequency) to the 170 SPS sites in the North of Tasmania.

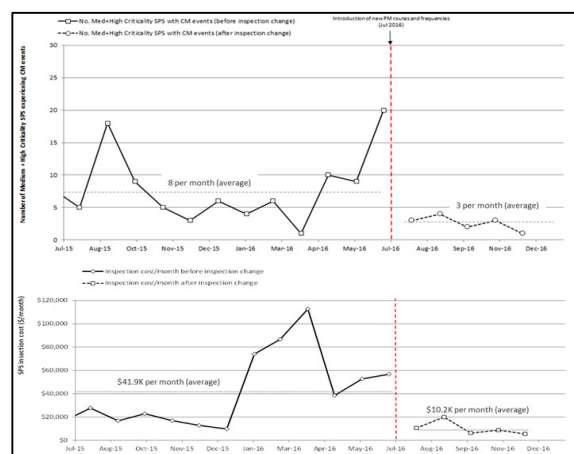


Figure 5: Visualisation of reduction in Preventive maintenance costs and corrective events against 170 SPS sites

The result of this work yielded a preventive maintenance reduction in operational spend of 75.7% coupled with a reduction in corrective maintenance events. This delivered TasWater a sustainable operational expenditure saving of approximately \$42,000 per month across 170 sites in preventive maintenance allowing repurposing of labour to other tasks. This augmentation of PM frequencies also reduced call outs to SPS reducing exposure to unsafe work environments. An encouraging result. The developed data visualisation for sewage pump stations and other asset classes now allows this process to be rolled out across the entire asset based including TasWater's 780+ sewage pump stations and actively track interventions.

3.5 Application to Decision Making – SPS performance monitoring

Our second case study involved performance monitoring of the entire SPS class. There was

a need within our business to understand key failure modes of pump stations and support renewals decision making; in particular, those pump stations which hold a high criticality and those impacting shellfish leases. The combination of data sources in an efficient visualisation allowed identification of an issue at one of TasWater's SPS in Sorell, a suburb in southern Tasmania.

The access to the visual tool for SPS performance allowed quick, simple identification of the sites causing TasWater the most concern month on month. The SPS in question, Forcett Street SPS, had incurred 8 corrective blockage events in after-hours scenarios, within 2 months, all as a result of rags. The root cause of these events was investigated through communications with our service delivery and trade waste divisions. The resulting root cause was identified as the nursing home upstream incorrectly disposing of wet wipes within the sewer network. This allowed conversations with the customer to be undertaken including education of correct disposal methods.

The key outcomes of this case study were:

- The SPS pumps were added to renewals program for replacement with a more suitable submersible pump set;
- Communications started with Coordinator in the area to assist in determining the root cause;
- Trade waste notified and investigated upstream customers (data provided to support discussions with cost to the business provided); and
- Customer communications were entered into.

There were also a number of secondary benefits as a result of addressing this issue. These included:

- Reduction in the requirement for after-hours callout and as a result reducing TasWater's call out costs; and perhaps the most important
- Improving safety of TasWater personnel by removing the need to work outside of hours.

The lefthand side of Figure 6 depicts the worst performing sewer catchment in relation to corrective maintenance burden against SPS for the period February through June 2017. As shown, the Sorrel sewer catchment was clearly the worst performing for the period and

justified further investigation. Through investigation, Forcett Street SPS was discovered to be causing the majority of the corrective maintenance burden. This issue is further elaborated on, investigating the Forcett Street SPS on the right-hand side of Figure 6. The image depicts the Corrective maintenance (CM and CM-U in green and black) and the Preventive maintenance burden (in red) of the Forcett Street SPS. The intervention, capital replacement of the pumps at the site was made in June 2017 including conversations with the Nursing home regarding correct disposal of rags.



Figure 6: SPS Sewer Catchment Performance (Left) and Forcett Street SPS Monthly Performance (Right) (Green and Grey = Corrective events, Red = Preventive Maintenance)

4 Conclusion and Lessons Learnt

The presentation and visualisation of data is crucial to developing knowledge and creating an agile organisation with fact based decision making. Taking the time to sit down with the correct stakeholders, ensuring consistency of approach and building effective visualisations removes the ambiguity between departments and drives the business towards a common language. The alignment of visualisations to a customer focus is incredibly important to ensure the operations of our asset bases are adhering to both Asset Management principles and building customer trust. Development of data visualisations, however, must poses tangible benefits and we must ensure we apply the correct lenses to really facilitate the business. While TasWater is only in the early stages of the implementation of business performance visualisation, the emphasis and focus aimed at development will drive us to be a more prudent and efficient business.

The key lessons learnt as a result of this case study were:

- Upfront early communications with IT around access to appropriate data sources is crucial;

- Key stakeholders must be involved in the initial development to ensure uptake;
- Visualisations must have a purpose with the end in mind otherwise the development will become a time and resource consuming exercise; and
- Any future improvements or modifications to visualisations must be tested against this purpose

As discussed in this paper, effective development of visualisations of data provides material benefits in terms of operational savings allowing for businesses such as TasWater to invest in areas such as innovation and reducing the cost to serve. Data and visualisation of data is truly the new currency of the water industry.