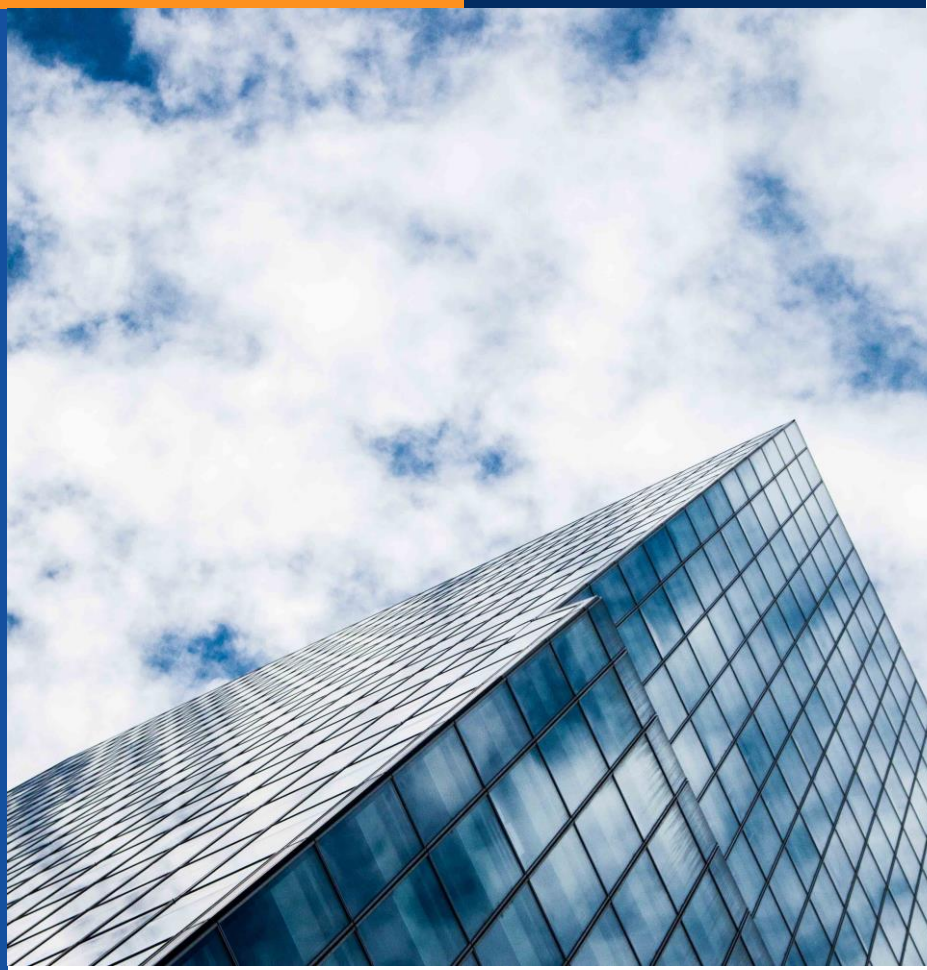
WATER SERVICES
ASSOCIATION OF AUSTRALIA

HARNESSING THE DIGITAL ECONOMY

A discussion paper for the Australian and New Zealand water industry



About WSAA

The Water Services Association of Australia (WSAA) is the peak body that supports the Australian urban water industry. Our members provide water and sewerage services to over 20 million customers in Australia and New Zealand and many of Australia's largest industrial and commercial enterprises.

WSAA facilitates collaboration, knowledge sharing, networking and cooperation within the urban water industry. The collegiate approach of its members has led to industry-wide advances to national water issues.

WSAA can demonstrate success in standardising industry performance monitoring and benchmarking, as well as many research outcomes of national significance. The Executive of the Association retains strong links with policy makers and legislative bodies and their influencers, to monitor emerging issues of importance. WSAA is regularly consulted and its advice sought by decision makers when developing strategic directions for the water industry.

Acknowledgements

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Executive summary

The digital age has developed at an extremely rapid pace. New technologies and tools can offer convenience, efficiency and cost savings to customers and businesses alike. Internet, email, mobile phones, SMSs, digital maps and online banking are all an integral part of everyday life for water utility customers as well as staff.

Australian water utilities are reasonably progressive on a global scale. In the digital space almost all have adopted some level of remote monitoring and system automation. A number have adopted or trialled smart meters, and some are using sensors and monitors to manage leakage, losses and pressure. Many are improving their customer interfaces and communication channels to benefit customers as well as improve business efficiency. Drones are starting to be used for high-risk or hazardous manual tasks. Further opportunities abound in smart controls, self-learning algorithms and machine-to-machine communications that can read SCADA, sensor and monitor data, develop and implement a course of action with little human interaction. Business insights can now be generated in real time through computer assisted analytics on multiple, disparate data sets. Correlations, opportunities and upcoming problems can be identified and addressed. Where this is done across multiple sectors, such as between water and transport, or water and energy, there can be significant opportunities to enhance customer value, improve business efficiency and minimise peaks and disruptions.

This paper suggests a four-part approach to digital maturity (Figure 1), which is structured from internal focus (left) to an increasingly external focus (right). Potential benefits from digitalisation are achievable at each stage. The internal approach starts with improving business maturity within business groups (far left) to establishing strong cross business integration (centre left), enhancing the interface with customers and suppliers (centre right), then finally leveraging tighter integration with the community and external agencies (far right). Whilst these stages are comparable to a business maturity model, the difference is that digital technology is allowing these advances in maturity to occur with greater ease and rapidity than in the past. Customers are starting to see many of these changes in businesses they interact with. Consequently, they are likely to expect and demand the outcomes that these advances can deliver from all of their service providers.

Australian utilities are at different stages of digital maturity, often with a mixture of components from each stage. This was identified by WSAA through the development of a Digital Utility Roadmap (a separate initiative involving 17 organisations) in which a four part approach to digital maturity is proposed[1]. While a step-wise approach is not needed, jumping to an external focus without first having prepared the internal business for digitalisation can limit a utility's ability to store, manage or extract the maximum value from the data collected and systems installed.

Whilst there are many benefits from digitalisation (Figure 1) there are also challenges and risks. Realising the full potential of digitalisation means considering a more integrated business, both internally and externally. This has implications for not only the business structure and supporting business tools but the culture and skills required to deliver. Externally, the changing nature of customer interactions and expectations are moving towards ever greater transparency and the need to source information in real time where possible. The integration and sharing of data with external

businesses provides untapped potential, but the business model for doing this and who is best positioned to extract full value from the available data is currently unclear.

The relatively new nature of digitisation can often make the risks seem daunting. The obvious risks of cybersecurity and data privacy occur at all stages and become greater as we move to more collaboration with external agencies. Protecting data communicated through the Internet of Things (IoT; internet-based machine to machine communications) is particularly significant because there are currently few standards, protocols and regulations in this area. The rapid pace of change in digital technology can make it hard for utilities to keep up with new developments, and optimising deployment is a constant challenge. The most prominent risk in this area is that of supplier dependency - becoming locked into proprietary software and tools.

However, the most critical risk for the digital utility is people, both in terms of change management and access to skills. Digitalisation presents some level of business disruption. It is essential that the change is well managed with staff. This includes good communication, consideration of cultural aspects and ensuring the right skill set to support the business moving forward. Skill shortage is an emerging risk as many businesses (not just water) simultaneously embrace the digital age and data analysts become in high demand. This is possibly more acute because the skills likely to be valuable in a mature digital utility such as IT, technology and data analysis have not traditionally been core business functions for water utilities. The digital age is challenging us to expand our skill set, engage with a new set of experts to extract maximum value for our customers and our businesses.

Slow adoption or movement to becoming a digital utility may not seem like a major risk. In the past there hasn't been a significant penalty for water utilities not moving with the latest technology or approaches. This is unlikely to continue. The mass connectivity and influence enabled by the internet is providing individuals with significant ability to affect even some of the more conservative parts of society. This coupled with customer expectations around transparency and timeliness of information means the industry needs to pay attention to the sleeping risk of slow adoption.

This discussion paper lays out the many opportunities the digital age offers water utilities, outlines the risks and challenges, along with how these can be managed. It concludes with some discussion questions on strategic knowledge gaps for the industry to consider. Addressing these will help optimally position the industry to embrace this exciting new era.

WSAA will continue to seek to enhance the capability of the urban water sector to harness the opportunities for closer and faster community and customer engagement, the power of efficiencies available through the internet of everything and new and deeper insights into business performance through data analytics. WSAA will also work with utilities and stakeholders to manage the transition in skill sets required to access the full benefits of the digital utility.

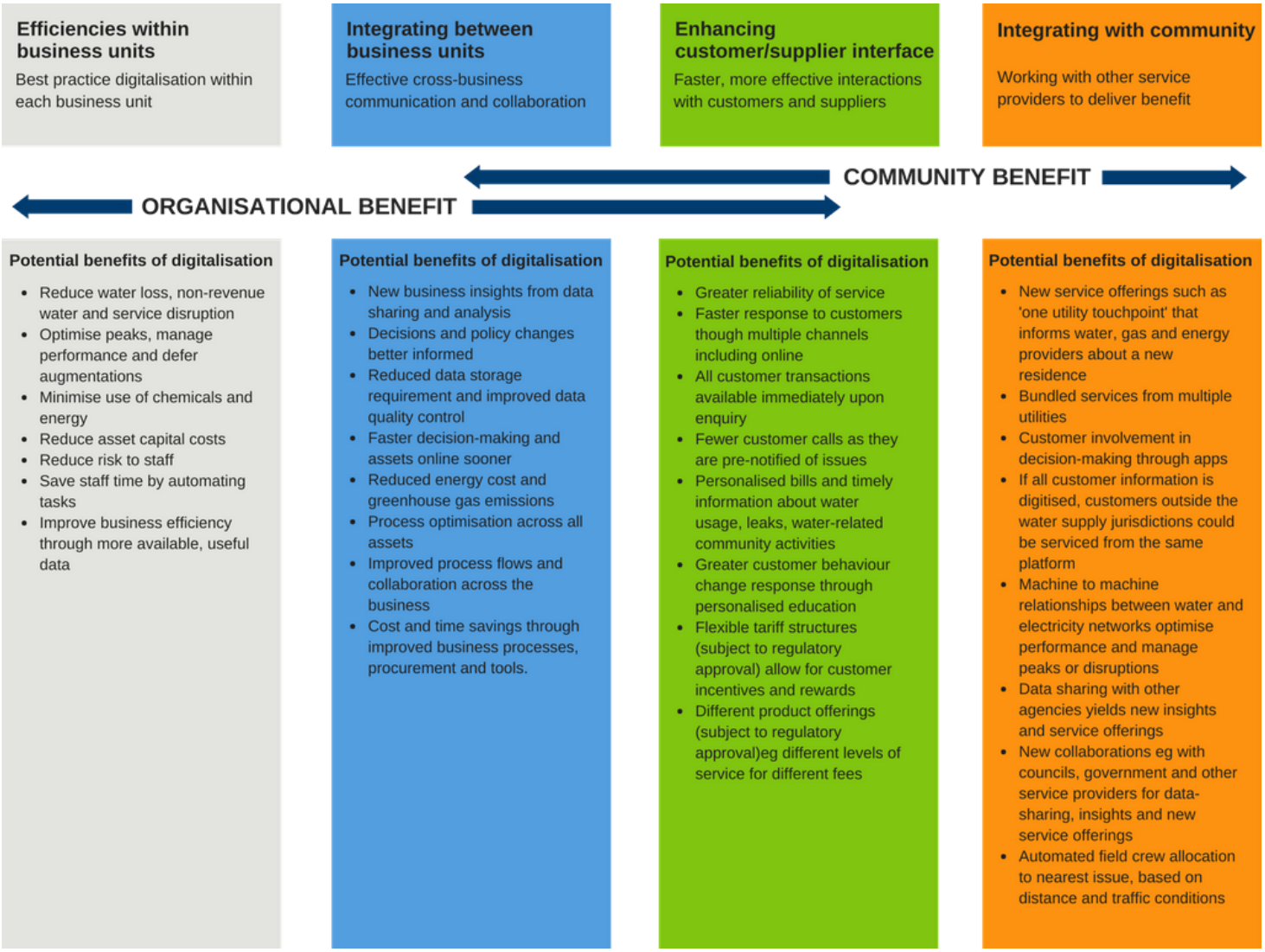


Figure 1: The four components of a mature digital water utility, from an internal focus (left) moving to an increasingly external focus (right).

1 Introduction

Digitalisation offers a wide range of opportunities for enhancing or re-imagining existing business processes in order to reduce cost, speed up resolution, minimise human intervention, assist decision-making and improve the customer experience. There are opportunities along the entire system including supply sources, network maintenance, network performance, customer interactions and market-based trading. The ability to gather, analyse and interpret large quantities of disparate data combined with automation are key enablers. The speed of data analytics and advances in monitoring devices bring about opportunities for optimisation not previously been recognised or achievable. The outcome is better service and value for customers through more proactive, informed and timely decision making.

This White Paper is based on interviews with relevant experts from within and outside the water industry, complemented with a desktop review. It discusses the benefits, risks and challenges in digitalisation for water businesses and provides guidance in addressing them. It also poses questions for the water industry to consider in developing its strategic directions and priorities for harnessing the digital economy. Recommendations for utilities on the digital journey are show in Appendix 1. The main body of the paper discusses benefits, risks and challenges and ends with key knowledge gaps.

A Digital Maturity Project that builds on this paper's findings was undertaken by WSAA in 2017[2].

Definitions

Digitalisation is the use of digital technologies to change a business model in order to deliver new revenue and value-producing opportunities[3]. In this paper the term digitalisation is used interchangeably with 'going digital' and 'digital utility'.

The related word **digitisation** is simply the process of changing from analogue to digital form.

Digitised content can be processed and transmitted over a computer network or the Internet, thus introducing a whole new paradigm in terms of power and application. Analogous to the Agricultural Revolution and Industrial Revolution, the Digital Revolution has already brought sweeping changes to society through digital computing and communication technology. It continues to the present-day and is forecast to accelerate enormously in the coming decades.

Digitalisation is a business change process and goes beyond sensors and meters. Networks and systems can be connected and operated remotely, and data and analytics can be used to better link causes and effects, as well as forecast and address future problems. At its highest level, digitalisation enables water utilities to become truly customer-centric but requires changing current processes, approaches and culture to fully harness the opportunity.

Drivers

The primary external drivers pushing the industry in towards digitalisation are optimising performance and improving customer service.

The 'millennium drought' (1997-2008) led to severe water shortages across much of Australia and most cities undertook major water supply augmentations. These included desalination plants, wastewater recycling infrastructure and large pipelines to shift water between separate river basins. Such augmentations were costly and led to significant, necessary price increases to customers. At the same time electricity and other utility bills were also rising steeply, creating general affordability concerns in the community. This has led to a

renewed focus by utilities themselves, shareholders (state governments) and regulators on optimising performance to improve efficiency. This is evidenced in the 2016 WSAA Asset Management Customer Value project, an international benchmarking project on asset management processes, which found the highest driver for improving asset management processes was efficiency.

Improving customer service is the other main driver for digitalisation. Use of technology to enhance service to customers is a global business trend across nearly all sectors. Customers are increasingly engaging in digital communications and in future will come to expect a digital interface for the majority of service providers. The rise of social media and particularly the ability for large numbers of people to connect online to share similar experiences changes customer expectations about service levels, and empowers people to do more about changing them. This is the so called 'democratisation' of customer service. In the past if a customer complained few people knew, other than through published statistics and the immediate contacts of the person. Now customers can vent their frustrations on-line to an increasingly connected population. This is moving customers into the controlling position around customer service. Water utilities are not exempt. The pressure directed at them can now be directly observed (often in real time) by their shareholders.

Smart use of digitalisation has led to benefits including lower costs, increased customer satisfaction, deeper engagement, and higher customer trust in telecommunications[4], electricity[5] and banking[6]. It is likely that water utility customers would also value enhanced digital services, and there is certainly evidence that water industry customers are requesting better digital services[7]. However it does not come without new risks and challenges.

Readiness

At present, the Australian water industry is at various stages along the journey towards digitalisation, and exhibit various levels of readiness to enter the digital age. Utilities that exhibit low levels of readiness may be characterised by lack of interest in new technology, lack of interest from the executive, and no digital strategy. Slightly greater readiness may involve watching what others do and learning from them, or undertaking small, isolated projects or technology trials. Businesses with moderate readiness to tackle digitalisation may start to address larger problems, and their executive exhibit higher levels of interest.

Businesses that have high levels of readiness will be solving large problems with integrated technology solutions, transforming their processes and services based on new digital business offerings. Their approach will be coordinated through a business-wide strategy with strong support from the executive. In order to fully harness the digital age businesses need to be ready and able to harness new technologies as well as undertake transformative, business-wide initiatives with the accompanying structural and cultural change. This is a challenge for highly regulated water utilities that are constrained in their products and services, nonetheless they are working to improve their readiness and deliver greater value to customers.

2 Potential benefits

This section describes how digitalisation helps utilities optimise performance and improve customer service.

2.1 Efficiencies within each business unit

Within business units there is a multitude of benefits from digital technologies and approaches, particularly in customer service and asset management. In customer service, digitalisation started with automation of billing and scripting of call centres. It has progressed further into customer engagement with installation of customer relationship management systems. The additional tools of channel migration, along with e-billing provide clear efficiencies for customers and the water businesses. In asset management, water utilities have been using sensors and meters to collect data for system optimisation for many years. In 2016 more than 30 Australian utilities had installed or were trialling smart meters.

Optimising Performance

Data

Better data management can yield a variety of benefits including faster decision-making, new business insights, forecasting and resolution of problems which reduces service disruption. This section outlines the technical changes you can make relating to data and the benefits each can bring.

Accuracy

Automatic data cleansing and assessment of data minimises the amount of inaccurate or incomplete data stored, clears space on servers and make it easier and quicker for staff to access and use that data.

Storage and availability

Faster access to the 'right' data with a 'single source of truth' for each data set for the organisation reduces data storage requirement and improves quality control. It is not uncommon for utilities to have multiple versions of data sets, which are not identical and have undergone differing degrees of quality control and gap filling. Storing multiple versions wastes server space, creates staff confusion over which data set to use, and lack of clear accountability and responsibility for checking and maintaining that data set. Moving to a single version of each data set will save money on servers, improve workforce efficiency and the reliability of reported data.

Cloud computing uses the internet to share and store data, processes and applications across devices such as desktops, laptops, mobile phones and tablets. It can be used to transfer data from water-related devices connected using the IoT, smart meters, sensors, monitors, SCADA and operational software. Operators could access this data from a mobile device anywhere in the field and alter the operations settings remotely. This could more quickly resolve issues, reduce the need for travel, and improve workforce safety. Other potential advantages of cloud computing are reduced energy and server costs, easier deployment of large software changes, and faster and easier recovery of lost content.

Real time

Having measured data from sensors, monitors and meters readily available in real time can reduce the work for operators who can control operations and intervene in disruptions remotely. It also allows computers to fill this role, analysing real-time data, determining and delivering a course of action. In another example, having real time customer-related

service data accessible in the customer service call centre assists staff in being more informed before they receive calls and resolving issues more quickly, thereby delivering a higher quality of service to customers.

Another example is water supply operations, which could potentially be improved though better access to live, system-wide data. Operations that can reduce leaks, attenuate peaks and use existing water resources more efficiently benefit the community and the natural environment by conserving water resources, and allowing for greater environmental flows and healthier ecosystems.

Analytics and forecasting

Through the analyses of disparate datasets, it is possible to elucidate unsuspected correlations and identify new ways to manage assets and networks. Instead of reactive data analytics that describe and assist a retrospective response to the occurrence of problems, assets could be managed pro-actively, forecasting future problems and undertaking works to avoid or mitigate the impacts. This is known as predictive analytics, as opposed to responsive or reactive data analytics. It can reduce operating risk and improve reliability of service.

There are several examples. Predictive analytics is already being used to improve the energy efficiency of pumps of in water supply pump and wastewater treatment plants. Smart meters and monitoring are being used to identify leaks early and repair them. Recent research shows that pipes leak before failing, so early leak detection and repair is particularly valuable as it can prevent subsequent service disruption due to pipe failure. Additionally, online sensors coupled with analysis of soil and external factors could provide real time information about probability of pipe failure, and be used to increase preventative maintenance to avoid a pipe burst. Resource planning and demand forecasting can also be enhanced through access to additional data, allowing for more accurate examination of the impacts of factors such as climate change, urbanisation and technology changes.

In the mining industry, predictive data analytics are used identify adverse road conditions, allowing drivers (or automated vehicles) to be directed to the best routes, thus reducing wear and tear and fuel costs. One company estimates that this could generate $14M savings per year.

In summary, accurate, available, real-time data can greatly assist utilities in managing their businesses. It can be used to more quickly inform decisions, to forecast futures, identify future problems and rectify them before they occur. Customers benefit from less service disruptions and potentially lower bills.

Automation

Automation can lead to quicker and safer asset inspections, reduced staff requirement in operations, cost savings in new assets, and better management of peaks. This section outlines the technical changes you can make relating to automation and the benefits each can bring.

Mackay Regional Council correlated locations of rainfall and source water quality data to understand impacts on source water quality. They learnt that rainfall in certain locations led to source water quality deterioration, whereas at other locations it had no effect. This enables more efficient, proactive source management and treatment.

Monitoring and control devices

Monitoring can be used to manage peaks in water supply, maintaining pressure and supply while attenuating peak demand where possible. If peak demand attenuated consistently, the asset life may be extended and infrastructure upgrades deferred. In the sewer networks smart systems are already being used to reduce peak loads to sewage treatment plants, reducing the risk of spills and deferring augmentations.

Historically, a lack of real time data meant that managing peaks in water supply and sewer network was done using hydraulic modelling based on limited calibration. The availability of low cost sensors, with supporting communications and power options mean much more data can be collected. The key is optimising sensor placement and configuration. At the simplest level system optimisation can be done by operators manually making adjustments in response to monitoring.

The next evolution is computer systems that read and respond to monitored measurements with alarms and notifications to assist the operator. There is still the need for a human to interpret the results, decide and commence any changes in operation.

The next stage of evolution is a programmed device to handle some or all of the response through machine to machine relationships within the water and sewage networks. The programmed device can identify a course of action and, where permitted, implement it without human intervention. Self-learning algorithms can make a program progressively more independent and less in need of operator input, and possibly exceed the capability of humans due to its consistent logic. This approach is likely to become more common due to the volume of data and increasing ability of devices to rapidly process this into information.

Changes in operation are made by remotely activating control devices. Control devices include valves that adjust flow into and out of tanks or reservoirs, and switches and electrical controllers that operate equipment such as pumps, aerators, agitators, turbines, gates or vents. For example, control devices can be used to automatically shut down certain water sources and switch to others following the automatic detection of poor water quality in a supply system. There are already many high risk engineering facilities that have sophisticated process controls and are operated remotely. For example, Snowy Hydro's gas-fired energy generation plant in western Melbourne is operated remotely from New South Wales. There is potential for the water industry to operate more of its assets remotely.

Research is ongoing to develop innovative analysis techniques to optimise the efficiency and safety of water systems feeding from multiple alternative water sources. For instance, if water supply data is linked with information about the availability of renewable energy and demand, the supply of water and the use of energy can be better coordinated. Excess renewable energy can be used for other purposes or returned to the grid.

Workforce safety and protection

Robots will be used increasingly in future for the handling of hazardous material or in challenging work environments that could pose serious health and safety issues. Melbourne Water and Seqwater have used drones for the inspection of dam walls and spillways, thus reducing inspection time dramatically. Instead of six staff working for a full day in a high-risk environment (abseiling), a drone can now gather the same amount of data in two hours. As a bonus, the images produced this way are of high quality, with GPS tagging that allows easy return to the exact location of an issue for targeted repairs.

Staff can be trained using 'smart helmets' with screens displaying guidance. Staff safety can also be supported with smart wearables, such as smart items of clothing, protection equipment or watches. There is an ever-increasing range of applications available, e.g. location-trackers which register staff entering or leaving dangerous areas (e.g. high fire-risk areas), 'wellbeing' detectors which can measure levels of drowsiness or heat exhaustion, and smart helmets that connect field staff to office-based experts who can virtually guide them through their task if required, this being particularly useful for utilities with skills shortages. In addition, the use of drones and other smart inspection methods can reduce the need for staff to work in high-risk environments such as heights or in confined spaces.

Greater automation of operator tasks, such as asset inspections or responding to SCADA alerts, can reduce the need for staff to work remotely or after hours. And overall better monitoring, modelling and predictability of asset performance may also enhance worker safety by predicting problems before they occur.

New asset creation

The advent of 3D printing presents a unique opportunity to reduce asset costs. At present commercial printing is primarily restricted to small scale plastic products. However, recent advances are looking at the options for 3D printing of larger items: with one project looking at printing an entire house, and there are several looking to 3D print steel foot bridges.

Customer channel migration

Customer service can be improved through offering multiple channels to connect with the customer: personalised and itemised smart-bills, social media, email, online chats, peer-to-peer discussions, mobile phone and tablet apps. This list will grow as technology progresses. Offering online chats as one of them can be efficient for utilities where one staff member can handle several online chats simultaneously instead of just the one phone call. This leads to either faster response times for customer enquiries or reduced need for staff. Customer relationship management software can be used to track and compile information from all the channels on each customer, providing a comprehensive view of that customer's issues and history with the utility.

Saving all customer transactions in one, easily accessible database can also be very beneficial as it stops customers from having to repeat their story each time they ring, and enables faster resolution of issue.

2.2 Integrating between business units

Digitalisation touches every part of a water utility. Successful digitalisation means that the utility has the tools, skills and business processes to harness new technology in order to ultimately improve their customer experience while maintaining (or increasing) returns to the shareholder. This section provides a simplified overview of the key elements of how a digital utility integrates its business units, including asset management, business processes and customer service. Culture is an overarching characteristic that underpins a successful digital utility transformation.

Improved customer service

By integrating data from all aspects of the business including billing, faults and emergencies, asset management and internal business processes, water utilities can set up new ways of creating customer value. Customer issues can be recognised more quickly through having the data on hand, potentially even before the customer calls to report a disruption. Customers will no longer need to repeat their story each time they call. Their issues can be resolved more quickly, and dealings will be more consistent and transparent. Some integrated systems in Europe are looking to provide a customer profile based on the incoming phone number that integrates the current bill, payment history, and network data. The system then tries to pre-empt and script for the top 3 reasons the person could be calling.

Integrating data from all parts of the business is challenging. It can be achieved by locating all data in one central repository, or linking staff across different business units that share their data as needed. Restructuring the business can assist in achieving this and is discussed further in Section 3.

Experiences of the energy sector show that customers who have interacted through digital channels over the last year have more positive attitudes towards their energy provider in terms of trust, satisfaction and willingness to interact further[8]. The same benefit might be expected for customers of water industry digital channels, if they are well designed to meet customer needs.

An integrated supply chain approach

An approach that considers the entire supply chain can offer more opportunities rather than focussing on only one part of it such as construction or operations.

Figure 2 shows an example using the asset supply chain with examples of the organisational and social benefits that can derive from improved water utility service provision. The feedback loop shows where utilities learn from measuring their organisational and social benefits and using this information to inform new asset strategies.

With regard to digitalisation, it is often tempting for water utilities to focus on step 4 of the supply chain (see Figure 2 below) where the direct benefits are more tangible. However, it is important to focus on other areas, because the higher up the supply chain the improvement is made, the greater will be the flow on benefit. For example see figure 2 below.

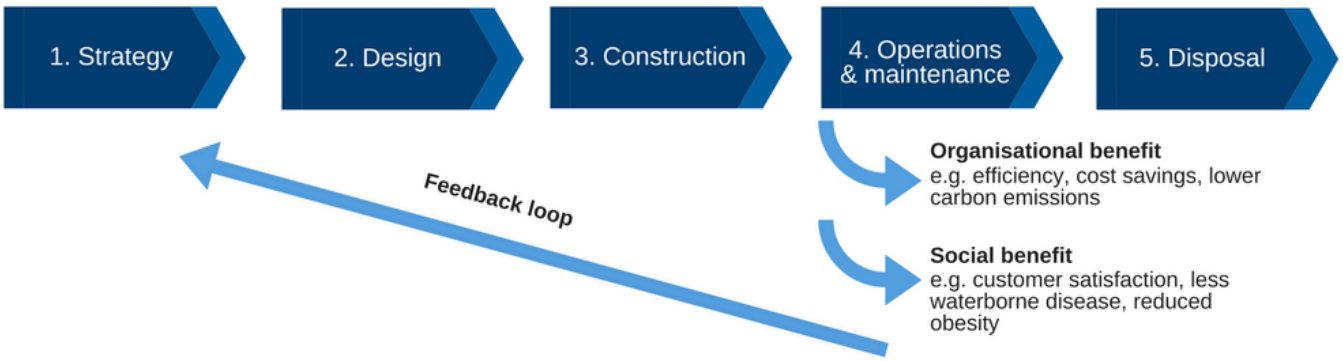


Figure 2: Asset supply chain

- **Collecting and analysing a wide range of data** to inform a high level strategy so that all major considerations are taken into account including the current situation and future trends (step 1). High quality data also enables assets and systems to be designed with greater accuracy and relevance (step 2).
- **Ensuring data is high quality and readily accessible** during planning and design (steps 1 and 2) will facilitate a quicker process. Delays due to collection and analysis of data at each stage during asset strategy and design may be significant. Reducing this delay by 20% in a five-year project will have the asset on line a year earlier, freeing staff time for other tasks.
- **Designing the asset differently** to reduce operating costs or to increase lifespan which, in turn, decreases the whole-of-lifecycle costs, even if the initial capital cost is greater (step 2).
- **Digital procurement procedures** that ensure each new digital asset is handed from supplier to the water utility with the asset data and data collection procedure in place (interface between steps 3 and 4), ready for validation and operation.
- **Demolition of assets** remotely through robotic means to minimise health and safety risks (step 5).

Additionally, creating a feedback loop between benefits measured in existing assets, and designing new assets (Figure 2), ensures that utilities can continue learning and providing maximum organisational, health and social benefit. For example, if installing improved controls in a water treatment process results in a reduced incidence of water-borne diseases in the general population, a case could be argued for using the savings in hospital costs towards funding such a process. Likewise, systems that exploit meteorological and environmental data to facilitate the watering of green spaces and to improve riparian vegetation management could lead to improved urban amenities. These, in turn, may raise house prices in the vicinity and part of the increased land-based taxes could potentially fund the cost of the program.

Improved business processes and tools

Digitalisation can facilitate more effective workflows and processes, thus reducing the need for human intervention. Digitalised processes lend themselves particularly well to automation and customer self-servicing. New software tools are able to find solutions far more quickly and better than humans can, such as those already available to optimise the allocation of expert field staff to the nearest most-urgent jobs. Telecommunication technology such as mobile networks, broadband networks, Wi-Fi, Bluetooth and near-field communication make data and information readily available wherever they are needed, whether within the office or out in the field, in one's own country or overseas. This means that work need not be delayed or impaired through lack of access to data or documents.

One study estimates[9] that digital transformation in the Australian Government could reduce the volume of transactions through traditional channels by 20% within 10 years: A$17.9 billion in saving through productivity and efficiency benefits for Government, and A$8.7 billion savings in time and convenience for citizens.

'Building Information Modelling'[10] (BIM) is a computer tool for construction projects that facilitates efficient construction and asset management. It can be used for more efficient management of construction projects within the water industry, and also improved management of the assets after they have been built. In the UK, the introduction of BIM has led to 20% cost savings on CAPEX, and the process is now mandatory for centrally procured construction projects in many European Governments[11].

Tailoring the procurement processes for digital assets and services can ensure each new digital asset is handed from supplier to the water utility with the asset data and data collection procedure prepared, ready for validation and operation. This not only makes the process quicker, it also ensures that the utility is collecting all relevant data from the supplier and minimises their work in validation and operation.

Through process optimisation, South East Water reduced time for developer applications from several weeks to days, including the ability for the applicant to track status. Digital self-service and customer online chat functions allow for more efficient handling of customer enquiries than traditional call centres as one staff member can handle several chats at one time.

Greater integration and processes around use of technology and data within the business can create a more agile workforce that better understands how the rest of the business works and can take their issues into account tin their own work. Digitalisation is not the only way to achieve this, but its nature which requires collaborative sharing to extract its full value, can provide a useful avenue for parts of the business to work together that may not have done so in the past.

One way of enabling the new processes and collaborations within the business is by changing its

structure. Flatter structures can better enable end-to-end integrated processes, for example. This is further discussed under 'Challenges'.

New business insights from data sharing and analysis

Traditionally water utilities have looked at data based on service function e.g. customer, asset, human resources. Using data from each section to build a complete picture of a utility's interaction with either an asset, customer or staff member often yield new, valuable insights, which facilitate better decision-making. New methods, models and tools are emerging for managing assets, construction sites and even budgets that are based on finding meaningful patterns and correlations within disparate datasets. These will assist decision makers who, otherwise, would not have access to the insights from the combined, large data sets.

In water cycle processes that use energy and/or produce renewable energy (such as mini-hydros or biogas capture) it is possible to use models which forecast water/sewage flows as well as energy demand and usage. They can be balanced in the model to determine optimal operating conditions, which supply all water needs, avoid sewage spills, while also minimising greenhouse gas emissions and energy costs. If energy is sold back to the wholesaler then these systems can work to ensure energy is being produced at times of maximum energy sale price. This integrated approach demonstrates one benefit of cross-business modelling and collaboration.

During a multi-year project such as capital works there will be many points at which data needs to be accessed and used to inform decisions. For example during strategy, concept, process selection, preliminary design and detailed design. For a large project or asset this may involve many gated approval processes. Having data readily accessible and in the right format speeds each step in the decision-making so assets are online sooner. Using correct protocols for requesting and storing data such as Building Information Management (BIM) ensures that the data is in the most usable format now and for future projects.

2.3 Enhancing the customer/supplier interface

Customer service improvements form one of the two key drivers of digitalisation for a water utility. The digital age has enabled a quantum increase in utilities' knowledge of their customers. A plethora of new communication channels, some of which are two-way, allow the needs, desires and sentiments of customers to be accurately and clearly discerned for the first time. In addition, the utility is able to determine much more precisely, the nuances of their customers' use of water through the smart metering of end use demand. Emerging technology allows this greatly increased knowledge of customers to be transformed into new ways of self-servicing or into entirely new service offerings.

A carefully considered interface with suppliers will also improve the utility's ability to extract the maximum benefit from digitalisation. This includes suppliers delivering digital technology or systems that utilities then use in-house, as well as expert service providers such as data analytics consultants.

Interface with customers

Customer at the heart of product and service creation

Looking at how other service providers are interacting with their customers sheds light on how some of these alternate channels can be harnessed. For example the banking sector has seen dramatic transformation due to digitalisation. Many banks now recognise that their success is tightly connected with their ability to implement digital technologies to automate processes, create new products, improve regulatory compliance, and transform the experiences of their customers, effectively self-disrupting key components of the value chain[12]. Likewise energy service providers have experienced greater levels of customer satisfaction, trust and willingness to engage through their digital channels with customers[13]. Water utilities are working to develop digital interfaces specifically targeted to customer needs.

Personalised interaction

The efficient collection of a vast amount of digitised data will enable the development of customer engagement systems with predictive capabilities that address and, where possible, rectify customer concerns before they contact the water utility. For

instance, customers may be informed via a timely SMS of a water main burst affecting their water supply and the expected duration of interruption. This notification is likely to reduce the volume of customer calls seeking reassurance or information. This reduces staff needed in the customer call centre, as well as boosting the utility reputation with customers who may see the utility as more proactive.

Using SMS notifications or emails, or in-house displays, utilities can communicate with their customers about their own water usage or leaks identified on the property. This requires a smart meter. Some customers enjoy learning about their water use and using it to help reduce their consumption. Likewise the utility can invite customers to community activities in their local area relating to water. Other personalised communication examples include alerts about emergency repair works in the local street, or a personalised message on their bill referring to a recent customer interaction e.g. “Thank you for reporting a burst.”

Currently many customers receive water saving tips from their utility as a part of their customer bill. Not all those tips may be relevant, for example not everyone has gardens so is not interested in sprinklers. By collecting and collating residential information, and water use behaviour and even appliance stock through smart meters or sensors, utilities would be able to identify the best water saving approaches for each customer. Personalised water saving tips could then be written on their bill to provide suggestions that are relevant for that person’s situation. It may result in greater uptake of water saving measures, resulting in overall lower water use and deferred augmentations.

The finding that 80% of digital energy users are likely to participate in an energy management program as opposed to 59% of non-digital users has resonance in times of drought when water utilities will be keen to promote water conservation[14].

Flexible tariff structures and product offerings

Digitalisation offers the prospect of greater customer choice to meet a range of customer needs, preferences or values. Subject to regulatory approval, flexible tariff structures could be used to incentivise certain behaviours. For example in areas with smart meters, time-of-use tariffs could be used to increase overnight water use and minimise daytime peaks, thus creating greater value for all customers through deferrals of asset augmentations.

Also subject to regulatory approval, alternative product offerings could be made available to customers analogous to what is offered by telecommunications and energy providers. For example, customers could pay more for greater levels of service. If some customers were willing to accept lower levels of service in exchange for reduced fees, there could be a net financial benefit to all customers by reducing the need to augment or upgrade assets that are constrained.

Improved data security

Blockchain technology[15] can be used, for example, to transfer money in a secure manner between two parties without using financial institutions as the middle man. Customers need not pay a financial institution transaction fees to transfer money on their behalf. Business processes also benefit from improvements in data security such as blockchain databases that are resistant to modification of data contained therein. While the application of blockchain technology is still in its infancy, some predict that it will revolutionise the way secure transactions can be processed.

Some pioneering governments, for example Estonia, already use it for tax and business registration systems. Water businesses could use the technology as an alternative process for payments, with minimal transaction fees. Budgets could be allocated upfront to be automatically spent on certain projects only and within certain timeframes, significantly reducing bureaucracy without sacrificing integrity. Likewise, new procurement processes and approval processes could be facilitated by blockchain technology.

Interface with suppliers

Procurement of digital services and technologies is different to buying traditional built engineering assets. Consideration of the digital-specific factors can help water utilities to more efficiently and effectively harness the digital age. The UK Government, for example, has developed a new

'Digital Marketplace' to improve digital procurement through all of their departments[16]. This section discusses some of the factors that may be considered in digital procurement.

Suppliers of technology or digital systems

Smart meters, sensors, monitors, computer system operations programs with self-learning algorithms, and customer relationship management systems are examples of digital technologies and systems that would typically be developed by an external provider then purchased by a water utility to be used in-house. It can be time-consuming for utility staff and technology providers to work out how to collect, store and validate the data produced, integrate it into the existing data management systems and operations of the utility. There can also be disagreement between technology providers and utilities over what constitutes a technology that is ready for use.

A more carefully considered handover with digital providers can reduce staff time and cost, and have assets on line earlier. Utilities may benefit from tailoring their procurement approach for digital technology and services to include factors such as:

- Asset data in the correct digital format to enter into the utility asset register,
- A specified data collection procedure,
- Instructions or assistance in how to calibrate, validate, integrate data into the utility operations and interpret results,
- A fully developed user manual, and
- Ongoing support from the provider for an agreed period to resolve issues

Suppliers of expert knowledge

Specialist data analytics expertise is needed to extract full insights from data. High levels of expertise are also needed to interpret results and their implications for the business, and use them to make decisions. There are other specialist types of digital expertise that also may be outsourced, such as development of specialist operations software with self-learning algorithms. In dealing with these expert suppliers utilities may benefit from:

- Considering how often they will need to access that specialist expertise, and whether it is batch-style work or ongoing. This will help inform whether they would be best to develop it as an in-house capability or outsource it.
- If outsourced, partnering with external suppliers on an ongoing basis to help the external suppliers build their knowledge of the business, and ensure ongoing access to skills that are in high demand from other businesses
- Training staff in the basics of data analytics or other digital expertise so they can effectively manage external suppliers and help translate the outcomes into business implications.
- Training the executive in the types of decisions digital expertise can inform, to assist them in their decision-making.
- Requesting copies of the simulations, data sets and models from external suppliers than undertake short-term contract work. This will reduce the need for the utility to repeat the work in future, and will make it easier for the utility to go with another supplier for related work in future.

Risks associated with skills shortage are discussed further in Section 4.

2.4 Integrating with community

This fourth, most external-facing part of water utility digital maturity involves working with other businesses, service providers and community groups outside the water industry to explore opportunities, insights, efficiencies and innovative service delivery options to benefit the broader community.

Community involvement in decision-making and initiatives

Digitalisation offers opportunities to involve customers and community members more easily in decision-making. For instance, this could be done through user-friendly mobile phone apps. The visual screens could also be used to visually demonstrate complex engineering concepts more easily. It can be quite difficult and expensive to involve the community in consultation regarding water and sewerage service options, so these novel digital options may help to increase the degree of consultation achieved.

One successful example of a user-friendly digital

representation of complex scientific concept was the Climatedogs videos[17] developed by the Victorian State Government. They were developed to help farmers understand the impacts of climate change on their farms, and plan their water orders and decide which crops to sow based on seasonal forecasts. Each of the global weather systems impacting Victoria's rainfall was represented as a different dog which had its own entertaining behaviour quirks. While this example was focussed on information dissemination rather than engagement in decision-making, it is easy to imagine a similarly entertaining approach being effective for water industry consultations.

An additional channel for interaction is now available with a range of smart city applications. They allow city authorities, infrastructure and utilities managers, and other city stakeholders to interact with their citizens on local issues such as reporting faults, administration and analysis[1]. They have the potential to improve the way a city is managed in a very democratic and personalised way and to increase the competitiveness, cohesion, and sustainability of the city.

Another example for combining customer benefit, customer education and city improvement is the "TreeWiFi" system currently being tested in Amsterdam[18]. Air pollution monitors, in the form of bird houses, are distributed across the city. If the pollution is below a certain threshold, the roof of the bird house glows green and it starts distributing free wifi access. When logging in via the "TreeWiFi", information is provided to show how everyone can contribute to lower pollution (and thus more free WiFi).

The water industry increasingly broadening the value it delivers to its customers in initiatives such as water sensitive urban design, greening the cities, and producing renewable energy. These novel digital approaches to engaging with the community could be used to consult the community on their preferences for new initiatives as well as collect feedback on those already delivered.

Customers from multiple jurisdictions serviced from the same platform

If all customer information is digitised there is the option for servicing from a common platform, external to the water business. This could make things easier for customers as well as reduce administrative overhead for utilities. However, it may come at the cost of having a direct customer relationship.

For example, the overhaul of Service NSW illustrates integration of different services for improved customer service. Nine hundred websites and 30 different contact centres were combined into one website and one phone number. The retail outlets offer a range of ways to interact with self-service stations in addition to the traditional service desks. Instead of having to visit separate agencies for a birth certificate and a new drivers licence, all can now be done in a one-stop-shop. The application for a senior citizens card can now be processed in 3 minutes instead of 2-8 days, resulting in very positive customer feedback (4.8/5)[19].

Environmental benefits

Environmental benefits can arise from the more targeted use of chemicals and energy in treatment processes, and optimised asset operations (of buildings, plants and transportation). Models can be used to predict the optimal treatment settings and dynamically adjust the process based on data from monitors and sensors. The net effect is reduction in chemical use, energy and greenhouse gas emissions.

In the future, enhanced environmental monitoring regimes may be required by regulators, which could be met with cheaper, smarter sensors supported by automated data analytics and reporting tools.

A number of utilities have examined the data on sewer spills, waterway quality, and community benefits to prioritise investment in sewer upgrades to the areas that provide the highest environmental benefit for the money as opposed to blindly fixing the most frequent spills. This is based on the premise that while some sewers may spill more frequently than the designated standard, the environmental impact of these spills may be quite

[1] This is one example for an open-source smart city app, which was developed by a European collaborative project: http://smartcityapps.urenio.org/

low.

Optimising performance across sectors

Earlier sections have discussed optimising performance of water, sewage, chemical and energy use within a utility. Potentially greater benefits can be obtained by taking a similar approach to optimise performance and manage peaks or disruptions between sectors.

Examples include sharing information between energy and water utilities to optimise performance and help manage peaks in both services. Once the interactions are well understood, machine to machine relationships between water and electricity networks could automatically optimise the performance of both systems with limited staff involvement.

Real-time data shared between water and transport services could be used to direct the water field crews to the closest disruption, based on both distance and current traffic conditions.

New collaborations, insights, service offerings and bundled services

New business value will come from sharing and using data, with information becoming a new strategic asset which allows value creation beyond traditional pipes and pumps networks[20]. New service offerings such as 'one utility touchpoint' that informs water, gas, and energy providers about a new residence could help improve the customer experience as well as reduce administrative overhead in utilities. Likewise customers may prefer to purchase and keep track of a single service offering of bundled utility services. Customers may currently purchase two utility services, such as gas and electricity, from the same service provider. In future this could be a bundle of water, gas, electricity and telecommunications. This could reduce administrative overhead costs in water utilities, though this saving may be small as on average only 4% of total water utility costs are associated with the retail interface.

Data sharing with other agencies such as councils, government, and other utility service providers may yields new insights, help us to better understand our customer base and provide for their needs better. There is already a significant private data analytics industry that uses data sets from different customer bases, to elucidate new insights into customers. This information is then sold on to companies that wish to selectively advertise to different customer bases. Much of the data is publically available but it takes expertise to extract meaningful and useful information. Water utilities need to think about whom to share their information with and under which conditions, to ensure their data is not used for purposes they do not support. Alternatively, water utilities can think about a new revenue stream based on using insights extracted from their customer data combined with other data sets.

For example in the energy sector, there are now 'energy providers' emerging that do not own any assets at all, but instead, use the decentralised solar panels of community members. They provide value through linking producers and users through an online, blockchain-based, peer-to-peer marketplace for renewable energy[21,22].

The IoT is a development of the internet whereby everyday objects have network connectivity, allowing them to send and receive data. Water utilities might consider how attaching sensors to all water using appliances in homes and businesses can revolutionise their understanding of appliance stock and customer usage pattern. For instance, it could be possible for water utilities to know exactly when showerheads are turned on and off as well as what temperatures and flow rates they run on. The information could be used for highly accurate operation of the water supply system for instance, or for more reliable long range planning. There will be many issues to work through as, for instance, should manufacturers or water utilities take the lead in developing the IoT for water using appliances? How can water utilities ensure that they have rights to the data, how can they use it ethically and who can they share it with? These are posed as discussion questions in Section 5.

3 Challenges

Digitalisation can involve greater challenges than with conventional projects as it affects staff, customers, suppliers and stakeholders. It calls into question some current business models and challenges the status quo. This section discusses the major challenges and some approaches for mitigating them.

3.1 Changing customer expectations

Customers expect an increasing level of control, personalisation and transparency from all service providers including water utilities. Government organisations are already falling behind the private sector, with 80% of public service leaders in Australia stating that: "Our digital capability is behind the private sector"[23]. To meet customer expectations, the water industry needs to stay informed of developments in the private sector, and understand the tools and channels available to meet customers' expectations, installing them where appropriate.

Like technology development, the expectations of customers may change rapidly in response to the digital services offered by other service providers. This challenges utilities that are trying to maintain high quality customer service and to build a reputation for innovation and service excellence.

One way of addressing this challenge is to develop (or recruit) customer engagement capability. Some utilities reported they are struggling to find and keep such experts in a highly competitive market so one solution may be to outsource this function.

An overarching customer digital strategy could also help address the challenges, considering topics such as:

- New and diversified channels for customer engagement,
- e-billing;
- SMS alerts, education and incentives to create 'customer pull';
- Building and maintaining customer trust when we know so much about them (e.g. how often they shower); and
- Driving regulatory change that would enable more variable tariff structures and incentives.

3.2 Workplace culture

To fully embrace digitalisation, a utility needs to adopt new ways of working, build new skills and capabilities and become more innovative, agile and collaborative. Even the best-designed technological systems can be easily undermined by a poor workplace culture. The ability to smoothly transition through the stages of digitalisation present a significant challenge to the industry.

Table 1 summarises typical differences between analogue and digital business culture, which serves to illustrate the degree of change required in culture. It may be seen that the digital shift affects the business to its core including ways of interacting with the customer, the organisational structure, staff attitudes and the way people work together. If not handled well, digitalisation may result in a divided

organisation with one part moving into the future and the other part reluctantly using the new tools, collaborating poorly, and ultimately undermining the digitalisation journey.

"There has been a fundamental paradigm shift. Today's customer expectations are 'If I can imagine it, it simply has to be there; if not, I'll invent it myself'."

Kim Williams, Australian Film Commission

Table 1: Features of analogue culture versus a digital culture, adapted to the water industry and based on work by PWC[24]

	Analogue culture	Digital culture
Customers and service	Products driven by supply Pushed into market Understands long-standing customers	Products developed to meet customer demand Understands digital customers and how to adopt new trends
Organisation	Layered hierarchy, silos Complex governance, slow decision-making Defined roles and tasks Process focus	Flat hierarchy Rapid decision-making Flexible employee roles to achieve a goal Product and result focus
Attitudes	Risk averse, accepts constraints, focus on past lessons learnt Career progression linear, defined paths Homogeneous teams	Vision, innovation, curiosity, improvement Strong collaboration Varied, rapid career paths, greater cross-sector and cross-industry staff movement Diversity in teams

A number of approaches can assist in meeting the challenge of cultural change. To achieve digitalisation goals, the 'agile' approach is already used by a number of water utilities. This approach builds new products in an iterative, 'test while you build' process. Typically, it is executed by a cross-functional team including those who understand the technology and those who understand the end-user's needs. It uses sharing, open communication, and visible support from senior management who ideally provide space and freedom for the team to deliver on the agreed outcomes. Alternatively, the *Lean Startup* approach is centred on a startup's core concern that they may create a product that people won't need[25]. It is useful in the early stages of product development to find out if a project is headed in the right direction[2].

An appropriately targeted cultural change strategy will assist in navigating to digitalisation. A good strategy will address the reasons for change, the pace, possible barriers and how to overcome each, and a change management process to ensure that all staff understands the process.

Starting small and achieving some quick wins can help illustrate to staff that a shift is occurring as well as provide them with immediate benefits. Involving all staff in the transition is essential. Ensure that they are sufficiently informed and supported and that they understand the overall business benefits associated with digitalisation.

Consider new incentives for innovation, risk-taking and collaboration, including recognising those who took risks but may not have succeeded. How is success rewarded and recognised? Is this different if the task was undertaken collaboratively? Consider new KPIs that encourage innovation; one extreme example from Google's innovation factory, GoogleX, is to reward staff for failure, as a way of recognising that they have tried to push the envelope while also having the courage to shut down a failed or failing experiment[26]. Some Australian utilities already recognise staff for submitting ideas that will be tested and explored, regardless of whether the idea will eventually be implemented. Acknowledging and valuing failure publicly would be taking this to another level.

A move to embrace a fully integrated cross business system will impact staff in terms of a potential cultural shift in how they interact. The cultural impacts of a change to a fully integrated system should not be underestimated. Effective cultural transition is critical to the success of the implementation.

3.3 Valuing and securing data

Data deserves the same attention as built assets. Do staff collect and manage it with the same care as they do with built assets? Do managers pay the same attention to it? Managers need to value and encourage data-based asset management solutions as an alternative to building new assets — for instance, transport planners are using data analytics to optimise traffic flows with timed freeway ramp signals, thus avoiding the need to build extra lanes[27]. An analogous situation for water utilities could be the analysis of customer demands and the introduction of time-based tariffs to delay or avoid the construction of new assets.

Privacy and security of data is a crucial challenge as utilities reach out to external organisations to optimise performance through digitisation. Customer data needs to be secure and protected. The operational data through remote monitors, sensors, valves, pumps and mechanical equipment and the IoT needs to be secure so hackers cannot interfere and create hazards to human health, community safety or the environment. These issues are further discussed under 'Risks'.

3.4 Rapid technology development

Technology is rapidly advancing. We are now seeing exponential adoption rates of new technologies[28]. For instance, the first iPhone was released in 2007, only 10 years ago, yet they have become ubiquitous worldwide. This means that while we may be able to plan for the next three years, it will be increasingly difficult to anticipate and plan for technology changes in 10 years' time.

To succeed in the future, businesses need to find new ways to keep up with the rate of change. This

[2] The Wikipedia 'lean startup' page gives a good overview of the various tools that *Lean Startup* offers, including Minimal Viable Product, Split testing, actionable metrics, build-measure-learn-loops etc. https://en.wikipedia.org/wiki/Lean_startup

is challenging. A recent survey of Australian public service leaders found that only 27% “feel confident about my organisation’s readiness to respond to digital trends”. Yet, 80% agreed that “Digital technologies and capabilities empower us to work better with customers and citizens.”

To address this challenge, businesses need to be agile, innovative, and well-connected to pick up on, and harness the latest trends. They need to be aware of major shifts to their service provision models that technology can bring, e.g. through decentralisation[3] or competition for managing customer relationship. Transforming the business structure and/or culture can assist in creating a workplace that is more agile to change.

Each of your smartphones is more powerful than the fastest supercomputer in the world of 20 years ago."

Kathryn Myronuk, Singularity University's director of research

3.5 Business structure

Digitalisation calls for a business structure that supports collaboration across the organisation and faster decision-making so as to deliver greater customer value. It is essential that the structure supports a workable approval process for time-critical digitalisation projects.

As shown in **Table 1: Features of analogue culture versus a digital culture, adapted to the water industry and based on work by PWC**, a successful digital business structure tends to have a flatter hierarchy than in an analogue business. This facilitates the breakdown of organisational silos so that multiple data sets can be connected to gain new business insights. Hence, data analysts are no longer associated with just one specific function but can understand various sets and their context across the organisation. However, if multiple teams rely on a single set of data, there could be a lack of clarity in terms of responsibilities and accountabilities. This would have to be addressed as early as possible.

Reviewing the business structure can underpin the cultural shift required to embrace digitalisation: a shift to being customer-centric, collaborative and innovative. In a truly innovative water utility this collaboration also goes beyond the business to share insights from the digitalisation journey with other water utilities, Councils, Government, researchers and the private sector.

For example, the Federal Government’s Digital Transformation Office has invested $50 million to modernise the centralised Government portal and, along with it, also reform the office culture. Staff across many teams are working collaboratively using agile approaches. Representatives from

[3] Decentralisation could be facilitated by water and sewer treatment systems available in ‘plug-and-play’ shipping containers (https://theconversation.com/the-plug-and-play-city-how-shipping-containers-are-changing-infrastructure-63125)

various departments mingle in a newly created co-working space where they regularly share codes and insights. This collaboration is extended to the public, who is invited to give very early feedback to 'beta' websites[29].

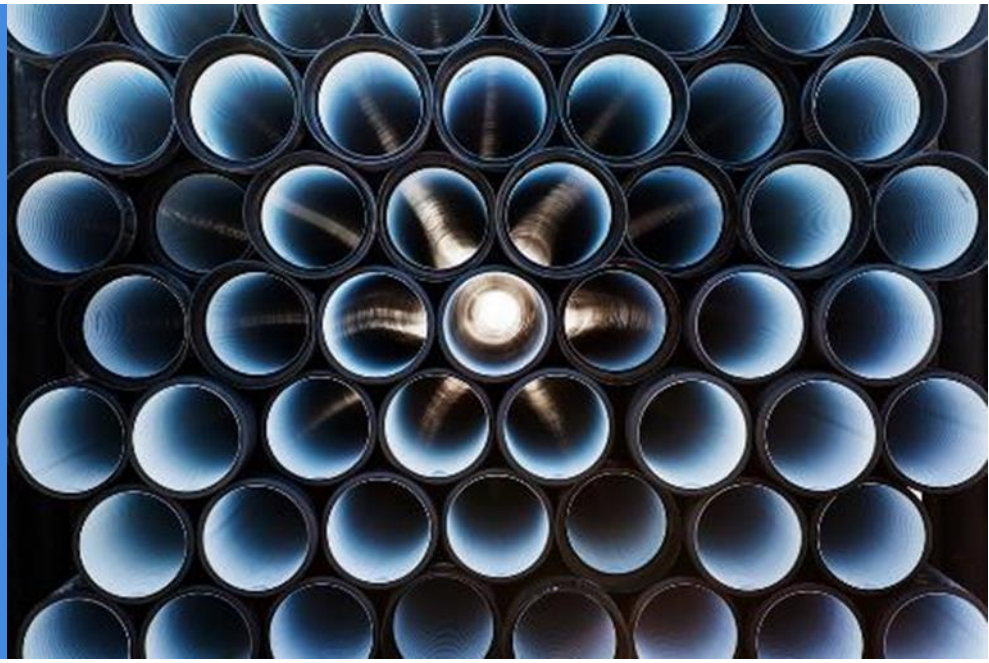
3.6 Considering the whole asset supply chain

The integrated supply chain methodology (Figure 2) is a useful, strategic approach but may be challenging to carry out. It requires:

- Different parts of the business to work collaboratively and all to inform strategy
- Financial assessment of whole of lifecycle costs for each asset
- Agreed methods and indicators for measuring organisational and social benefit
- Recorded, cleansed, accessible and interoperable data sets about each given asset across its whole lifecycle. This may require cleansing historical data sets and filling missing data.
- Developing a process by which new data collected is analysed and provide insights to inform new strategy without delay.
- A workplace in which staff see the value of the supply chain and feedback process, take responsibility for carrying it out, and have a basic data-literacy to engage in discussions and understand how the data can provide value to their work.

These are all significant challenges for many water utilities and will require a united, whole-of-business approach to succeed.

One major challenge for water businesses in considering the whole supply chain is the significant shift that will need to be made from current internal workflow and processes. Changing the business structure and culture will help enable this shift.



3.7 Procurement of digital technologies

Procurement of digital technologies and digital services is worth considering as a messy handover between supplier and utility can waste staff time and limit the value the utility can extract. For example, staff can waste time calibrating and validating new technology if a data set of standard operational outputs for that technology is not available. Likewise if a full, organised, interoperable data set is not handed over once a digital service is completed, the utility may not be able to proceed with the next phase of work. At worst, a part of the work may need to be repeated, wasting both money and staff time. There may be a need for staff training at handover in order for them to understand, use and maintain the new technologies effectively. Public sector procurement processes are starting to be tailored for digital services and utilities may benefit from tailoring their own processes similarly.

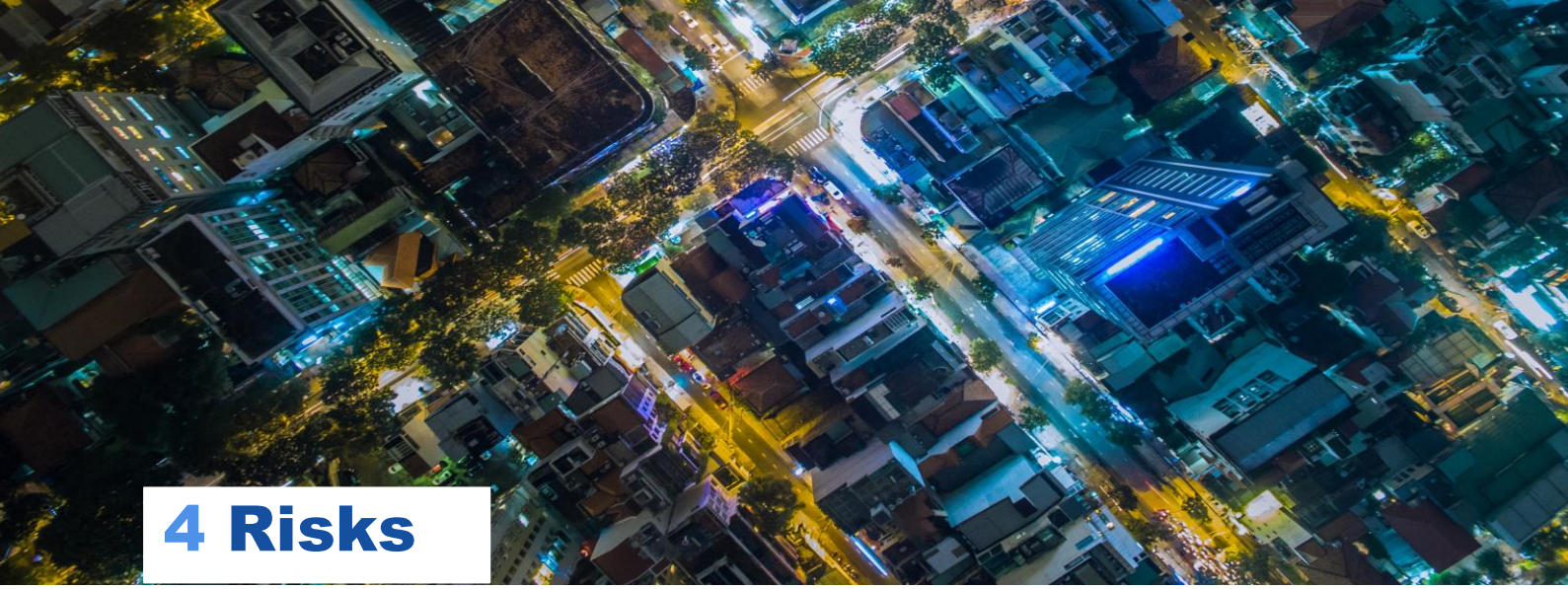
3.8 Building a business case for customer value

While digitalisation has been shown to save utilities money, it is can be difficult for utilities starting on the digitalisation journey to build a strong financial business case for investment. This risk can be mitigated by clearly identifying one small, clear problem to be addressed. Once the benefits of the first step are measureable, subsequent phases may become easier. Some opportunities may have very little financial outlay, such as better analysis of existing data sets, or filling gaps in existing data sets, to provide new insights. A business case can also be strengthened by including any non-financial benefits in a qualitative manner.

Building a business case for delivering greater customer value can be even more challenging than other digitalisation projects because it is unlikely to result in increased revenue. Given Australian water utilities are monopolies, the benefits of delivering better customer service are more likely to be improved reputation or customer satisfaction levels. In selected cases there may be financial benefits in terms of more efficient use of staff time. Basing the business case on non-financial as well as financial benefits can help.

3.9 Collaborating with other businesses

Earlier sections have highlighted some benefits of working with other businesses such as energy providers and transport. Although there are advantages, working with others that operate under different business models and regulatory environments may also pose challenges. For example, private service providers they may be free to use their data in a different manner, or generate saleable information or products through data insights that water utilities may not support or may not be able to share in.



4 Risks

While there are massive opportunities with digitalisation, there are also significant risks that water utilities will have to address in embracing the new technologies. As most of these risks can be foreseen, mitigation strategies can be put in place beforehand. The major ones are discussed.

4.1 A lack of clear direction – a disjointed approach

An integrated supply chain approach (Figure 2) should consider all parts of the business, and how they will work together to collect, manage and extract value from data. Nonetheless, as is often the case with IT, digital hardware and software are not always perfectly compatible; multiple components are needed to deliver different business benefits and all components have different strengths and weaknesses. Implementing digital components without a coherent overarching plan risks delivery of a final solution with gaps, incompatibilities and unnecessary expense. Step changes in digital technology can also be disruptive to internal workflows as new systems need to be developed, tested, trialled, and then integrated to become business-as-usual. There are inevitably unforeseen challenges and problems.

A clear digital strategy will help mitigate the risk of a disjointed approach and identify the most promising areas to focus on. Yet, a recent survey of Australian public sector leaders showed that only 35% of them have a clear and coherent digital strategy[30]. Elements to consider in a digital strategy include:

- A clear, measureable business problem that you are trying to fix;
- Reasons for digitalisation;
- The overarching roadmap;
- Customer service (satisfaction and benefits);
- Staff skills;
- Technical challenges;
- Business culture and business structure;
- IT architecture and security, and
- New business models and service offerings that may emerge.

Another way of mitigating the disruptions associated with shifting to a new digital system is to set up a ‘multi-speed’ approach which allows the business to test and integrate new data management and analytics systems while guaranteeing stable performance of the existing system. This relies on an excellent understanding of the existing IT infrastructure, supporting data and applications, along with an understanding of how they each contribute to serving the customers.

Figure 4, on the following page, provides a useful way of reviewing your business’ digital aptitude before embarking on your digital journey.

Vision and strategy	Customer insight	Skills	Business processes	Technology and data	Governance
• Do you have a clear vision and goals? • Do you have a cross-business engagement strategy? • Is there strong executive support?	• Do you know your customer segments? • Do you know what each segment wants from digitalisation?	• Do you have a plan to secure ongoing access to talent? • Do you need to train your staff and executive to make decisions involving digital insights?	• Do you have efficient processes to work both within and across business groups? • Does each process add value to the customer?	• Do you have a 'single source of truth' data set? • Do you have cloud and mobile access? • Have you structured your back end platforms for agility?	• Do you have clarity over data ownership, integrity and deletion rights? • Are senior technology staff involved in key business decisions? • Do you have appropriate risk management around data sharing and security?

Figure 3: Strategic issues to consider regarding your digital business aptitude, tailored to the water sector and based on work by KPMG[31].

4.2 Cybersecurity

Increasing the use of internet-based digital channels, technology and processes can improve efficiency and customer service but also means that more parts of the business are vulnerable to cyberattack. This could take the form of stealing private data, such as customer use data. For example, smart meter data could be used to identify when the house is vacant, then people could enter the property illegally. Or large amounts of customer data could be stolen and sold to firms that can analyse it, profile the customers and then use it to selectively advertise to them. Tampering with the data and systems that are used to operate water utility infrastructure could have a far more serious effect, such as cutting off water supply, disrupting treatment processes to spread water that is not fit for consumption, flooding houses and sewer overflows through disrupting sewage pumping, or harmful environmental discharge from disrupted sewage treatment. Any such disruptions could be possible by hacking into any internet-based system that connects and operates remote infrastructure.

One particular area that carries new and unusual cybersecurity risks is the IoT. The Australian Communications and Media Authority has summarised emerging issues around the IoT, including the potential of amplification of impacts in any network or national security breaches[32]. According to one IT security expert[33], there are significant security issues that need to be considered, especially when considering the applications of IoT across water networks. Much effort is currently focussed on network perimeter security - keeping attackers out of our servers, etc. but less effort is being spent on ensuring the confidentiality and integrity of the data itself. When data is not encrypted and signed, it's vulnerable to theft and forgery. For example, in the last few months, over 600,000 patient records were stolen in three attacks on clinics in the USA. Imagine, in an IoT environment, data can not only be stolen but forged before it is sent back to the utility. Forgeries can be hard to detect, for example, water quality may seem fine because the sensor indicates that it is but the sensor could be vulnerable to an attack. Blockchain technologies may be of significant assistance in this space as they are designed to preserve the integrity of data. Cybersecurity risks with IoT and possible approaches to resolve them are listed in **Table 2**. Encryption is one very effective way to protect data and digital operations from cyberattack.

Security and privacy challenges for the IoT		
	Issues	**Approach towards solutions**
Security	Internet security concerns are not new, however the IoT brings them to a new level. Every IoT device that is connected to the internet potentially affects the security and resilience of the internet globally. Ensuring IoT security must be a fundamental priority, to create and maintain trust in the devices and services.	Collaborative approach to developing security protocols and standards. Exchange information about challenges and solutions.
Privacy	Many IoT applications have the potential for increased surveillance and tracking. Concerns about privacy and potential harms may hold back full adoption and acceptance of the IoT	Strategies will need to be developed to respect individual privacy choices across a broad spectrum of expectations. Standards and regulations are required to underpin these strategies.
Standards	Standards are critical to achieve best practice operation of IoT devices and resolve issues of security and privacy. Additionally to safety and privacy concerns, standards are also important to create interoperability across different systems.	Unified standards will enhance security of devices and curb the proliferation of devices that may act in disrupted ways to the internet. Currently there are a range of (competitive) standards being developed.

Table 2: Security and Privacy challenges for the IoT[34]

4.3 Skills shortage

WSAA's Workforce Skills of the Future paper identifies that the core skills of the future are changing and businesses need to develop new ways to identify and recruit these skills. Talent management and change management will be critical given the transformational forces impacting the industry[35]. Resilience and flexibility, leadership, digital and technological literacy and critical problem solving are likely to be the most important capabilities. From a digital perspective, skilled staff are needed to process the data, turn it into useful insights and actions, and communicate the insights to senior management who may not necessarily be technically-minded. Customer engagement experts are also required to harness the digital information and transform it into excellent customer service.

All these staff are currently in short supply. A number of recent surveys showed that there is a big shortage of data analytics experts[36], with 40%-70% of the companies surveyed struggling to find and retain the data analytics talent[37,38]. In addition, there is an even greater shortage of people who speak the languages of both data analysts and decision-makers and who can create a bridge between the two[39]. Some utilities have also reported they are struggling to find and keep customer engagement experts in a highly competitive market.

As data analytics is not core business for most water utilities in Australia, it is likely that most will

outsource the service leading to the potential risks of supplier dependency (further discussed as a separate risk). At least a moderate level of in-house skill is recommended so that the data analytics service providers can be effectively managed and insights can be successfully communicated internally to inform business decisions. Customer engagement expertise is closer to core business for most water utilities so this expertise could be developed in-house or outsourced; however, regardless of the approach chosen, it may still be difficult to hold onto staff. The business employee value propositions may assist in attracting and retaining highly sought-after experts.

Digitalisation may change the way water utilities are led, with new roles such as: Chief Digital Officer, Chief Customer Officer, or Digital Water Steward[4] emerging. It may also be beneficial to up-skill all the decision-makers so they have an ability to interpret analytics results and translate them into targeted actions. Indeed, the respondents to a recent survey found that 40% of their senior managers had 'only a moderate understanding of the importance of digital skills', while 26% were believed to have 'little or no understanding' at all[40].

"Most companies have come to an understanding that digital change is a macro factor that impacts strategy in their industry. Most have decided to improve their capability, and they have understood that this requires a new kind of leadership."
Gartner Technologies

4.4 Dark data

New data is being produced at an extraordinary rate: 50% of the data existing worldwide was generated in the last 10 months[41]. Most data remains under-analysed, presenting a real business risk and cost. The Veritas Databerg Report estimates that by 2020, worldwide $4.6 AUD trillion will be wasted due to gathering and storing too much data that is not being used[42]. Figure 4 illustrates that only 10% of current data collected in Australia is tagged as 'business critical' while 62% of it remains 'dark' (of unidentified value) and 28% are ROT (redundant, obsolete or trivial).

[4] "Queensland Urban Utilities has identified three core functions that a digital water steward could have in the future: management of intelligent water networks; integrated planning for people, places, products and profit; and management of 'digital ecosystems' that are 'customerised' (custom made for customers). In addition to this, the collection, analysis and use of data is critical to business success" [Louise Dudley, UtilityMagazine http://www.utilitymagazine.com.au/the-utility-of-the-future/]

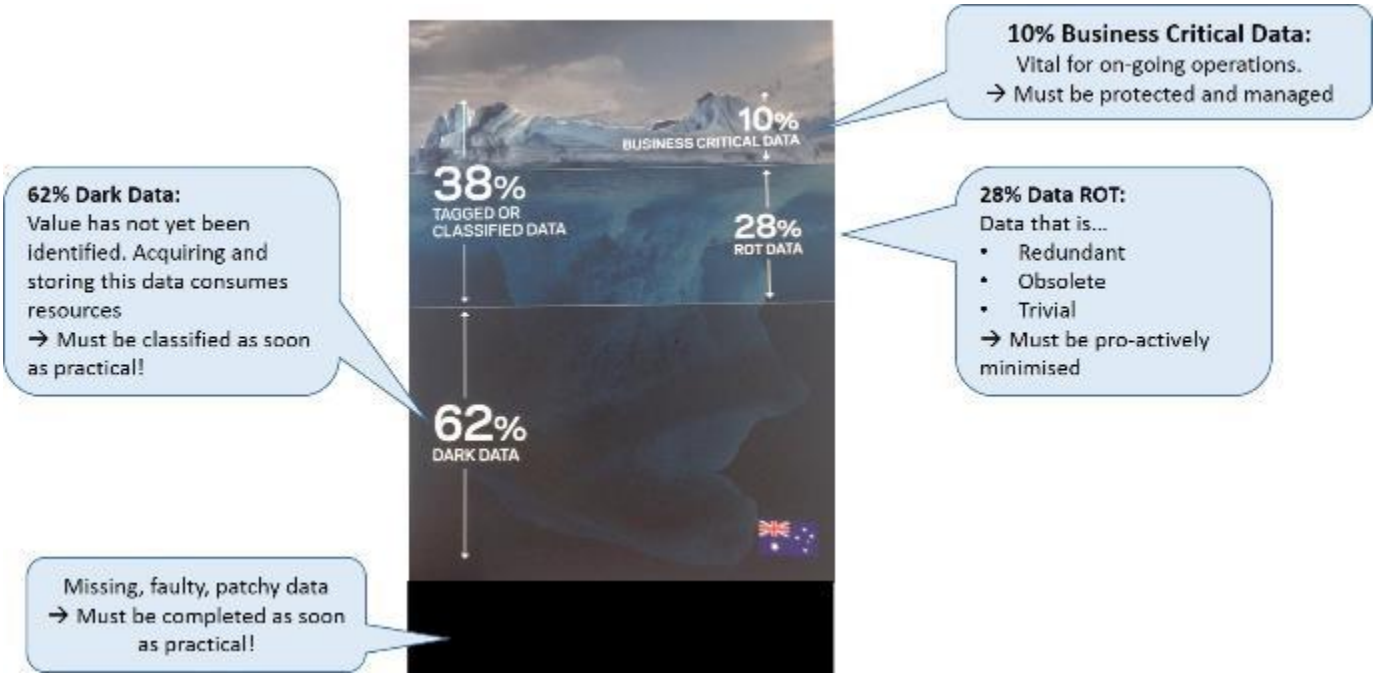


Figure 4: The Australian databerg[43].

Table 3 summarises potential risks associated with dark data. Possible mitigation measures are suggested in Table 4.

Table 3: Risks from not knowing what data is saved where and in what form (encrypted or not)[44]

Legal and regulatory risk	Risk of legal liability if data that is covered by mandate or regulation is insufficiently protected (due to unawareness).
Intelligence risk	Risk of inadvertent disclosure of sensitive / proprietary information.
Reputation risk	Risk of reputation damage if any data (including dark data) is exposed.
Opportunity cost	Risk of lost opportunity if an organisation outsources the analysis and mining of dark data, or deletes it prematurely.
Open-ended exposure	Risk of not seeing critical trends because the data is not analysed.

Table 4: Possible ways to mitigate risks posed by dark data[45]

Ongoing inventory and assessment	Conduct regular audits to identify dark data. Research tools and technologies to help extract the value. Understanding what the dark data is will help to create the controls to maintain its security.
Ubiquitous encryption	Proper encryption, no matter if the data is stored on the company server or in the cloud, will guarantee that the data can't be manipulated or accessed. If in doubt, give it the maximum protection.
Retention policies and safe disposal	Develop data-retention policies to guide how to identify non-critical data for deletion. Have safe methods for erasing and destroying the data.
Auditing dark data for security purposes	Include dark data in your periodic security audits, to evaluate risks, exposures, incident response and policy.

Questions for water businesses to understand their dark data risk include:

- Do we know how much of our data is redundant, obsolete, trivial or unidentified?
- Is it clear which data we are currently collecting is useful, and which can be discarded?
- Do we have a process in place to cleanse data?
- How much is it costing us to store our dark and ROT data? If we were to identify and delete obsolete data, could we use the savings to improve our ongoing data management?
- To what extent is outsourcing of data analysis acceptable? Should we buy our own servers, or could we share them with Government for instance? Can we access platform software or must we run it internally? How do we encrypt our data before storing it, as an additional safety measure?

4.5 Regulations, governance and standards

Policies, regulations and industry standards are in their infancy for emerging technologies with the IoT being a prime example. Like the recent example set by Uber, technology with wide-ranging impacts can now be very easily deployed with little regulatory oversight. The rapid rate of change in technology frequently outpaces the ability of the associated policy, legal and regulatory structures to adapt. For instance, legal issues with IoT include:

- Cross-border data flows (especially if data protection laws between the parties differ);
- Conflict between law enforcement and civil rights;
- Conflict between data retention and destruction policies; and
- Legal liability for unintended uses, security breaches or privacy lapses.[46]

Internally, businesses need to be clear about the boundaries of using and sharing their data, and how it has to be managed and maintained. Poorly executed data sharing could lead to an accumulation of un-analysed data, data security risks or even worse, asset functionality risks. Recently, hackers disabled a car while it was travelling at 70 Mph[47]. Imagine an automated water treatment plant being hacked, resulting in a serious water quality issue.

Sharing data sets between sectors can assist in managing critical assets and providing coordinated planning, particularly in areas where the existing infrastructure may be limited, old, or under-sized compared with the new demands. Water utilities could also benefit directly, from buying and selling power at times with better prices, and by directing maintenance crews along routes with less traffic. There have already been significant data sets collected and collated in Australia[48,49] and other countries[50,51].

If the end goal is to share high quality data sets between different industries in Australia, there may be benefit in discussing standardised data protocols, formats and metadata that can be used. Water utilities could then consider using this format in their own data warehouses, tailoring and adding to it as needed to meet their own internal data needs. Failing to agree on a framework and format for shared data may lead in unnecessary costs to all sectors, as a result of translating and reformatting. It might be beneficial for the urban water industry to influence the standards being developed around the IoT. The opportunities for strategic influencing are further considered in Section 5.

4.6 Supplier dependency

Many digital technologies are available from private suppliers and they are not all compatible with each another. The risk for water utilities is that they may become locked into one particular brand or supplier, which may not be in business indefinitely and may not be able to provide the ongoing support needed.

Likewise, partnerships with external service providers in data analytics and/or customer engagement are likely to be a part of any digital transformation. These services are in high demand and it may be very difficult for utilities to forge an ongoing, reliable and cost-effective partnership with a single service provider.

Communications systems have traditionally been a

major challenge, however, recent developments have seen a move away from proprietary systems to more open source networks with increased competition. Various LPWA (Low-Power Wide-Area Network) communications systems and solutions are emerging. The Australian Communications and Media Authority has recently set aside a certain frequency spectrum (929-934 MHz) that will, once implemented, be available for IoT applications[52]. Telecommunications companies are increasingly investing in these LPWA networks. A number of utilities are already trialling NBIoT, ("narrow band Internet of Things", one type of LPWA technology) with various suppliers[53]. Selecting suppliers using open source networks are inherently less risky than using suppliers with proprietary systems.

Finding the right strategic partnerships may assist in mitigating the risks. Collaboratively, organisations can leverage skills, capability, technology and costs. The increased availability of communications providers (all using the same LPWA technology) is an important step in creating competition in the market and driving down costs. There are already a large number of proprietary tools available for big data analytics that allow analysis of big data sets[54], however, it might also be worth considering open-source platforms[55].

4.7 Late adoption

Although there are risks with shifting to digital technologies, there are also risks with being a late adopter. Digitalisation can offer very substantial cost savings and greatly enhanced customer service. New technologies may also play a crucial role in meeting increased levels of service without increasing costs or just being able to guarantee current levels of service under increasingly demanding circumstances such as drought, aging assets and urbanisation. In short, digitalisation can boost customer satisfaction and the utility's reputation with customers.

Utilities that do not start the journey risk becoming inefficient and out of touch with their customers. Despite being monopolies, they could come under considerable pressure from their customers and regulators, as well as suffer considerable reputational loss. Late adoption or lack of adoption could leave a water utility struggling for relevance and survival in a changed world.

5 Critical knowledge gaps

The following questions are intended as a prompt for discussion about key areas that need to be resolved in moving to the digital utility. Consideration of these factors should help to prioritise which work should be progressed at a national level by WSAA, and help provide clarity on the research and development priorities for the industry.

1) **Defining the business:**
   a) Which business is the water industry in? What systems are we seeking to understand and optimise in the future? Would we consider new revenue streams based on extracting insights from our customer data combined with other data sets?
   b) How important is a direct customer relationship? Do we want to maintain this relationship at all cost?
   c) Which parts of the business relating to digitalisation should not be outsourced?
2) **Running the business:**
   a) What are the skills needed to harness the digital economy?
      i) Who could we collaborate with to maximise learning?
      ii) How do we ensure an ongoing supply of specialist expertise?
      iii) Should we train our decision-makers and staff in the fundamentals of digitalisation and data to help them direct work and use data insights to inform their decisions?
   b) What is the optimal mix of IoT options to drive efficiency? And how is this to be developed, based on the kind of business you are in?
   c) What is best practice governance around the IoT and the data generated? For example:
      i) How can we ensure that we have full access to and rights over data that is collected through third parties (e.g. in apps)?
      ii) How can we use customers' water consumption data, who can we share it with, and to what level of granularity?
      iii) How can we ensure that the way we use the technology is ethically acceptable? (e.g. would it be acceptable to track people's activity while at work, or to notify people who water their gardens at the peak of a hot summer day?)
   d) Considering all steps in the supply chain, is there some work that would be more efficiently delivered collectively? For example, developing guidance on tailoring procurement processes for digital goods and services?
   e) With whom would we share our operations or customer data, and under which conditions? How do we make sure the data is not used for purposes we do not support?

3) **Future-proofing the business:**

   a) What external factors might accelerate digitalisation in the water industry? What are the game-changing innovations we can predict that will require a policy position, new regulations and standards, or advocacy?

   b) What are possible new business models that could disrupt our industry (e.g. through decentralisation, off-grid systems or information-based value creation)? How can we prepare the business for disruption?

   c) How can we future-proof our built assets? Are new standards required, e.g. to allow later addition of sensors?

4) **Strategic partnerships and influencing:**

   a) How actively should the water industry be involved in the development of the new standards and regulations for data ownership and protection, privacy, security protocols, and the IoT?

   b) Do we need to be working further with the Federal Government to develop a framework and standards for an open data set accessible to all?

   c) Should the water industry be working with others that are developing a framework and standards for an interoperable data set across sectors?

   d) Is there potential to share smart infrastructure (communications systems, servers) with other utilities or organisations?

   e) Where are critical new partnerships for data sharing in order to generate new insights (Bureau of Meteorology, Governments)?

Appendices and Reference

Appendix A: Recommendations for utilities on the digital journey

Prepare the business

- Map existing technology, IT, data, applications, data-related governance and processes
- Identify business problems that could be addressed by digitalisation
- Understand your level of cyber security risk.
- Identify potential technological disruptions and prepare for them.
- Stay abreast of technology and customer service developments.

Efficiencies within business units

- Select a small, manageable problem to solve
- Analyse your existing data sets to extract insights
- Recognise the value of data equally with built assets.
- Consider scalable and open source solutions to reduce supplier dependency
- Actively manage the amount of data that is stored on your servers.

Integrating between business units

- Look for opportunities across all steps of the asset supply chain
- Build business cases on financial and non-financial benefits.
- Create a digitalisation vision and strategy.
- Plan your culture change process. Make it easy for staff, identify quick wins, and incentivise innovation.
- Consider a business structure that's more responsive to change.
- Train decision-makers on big data and its insights.

Enhancing the customer/supplier interface

- Access expertise in customer engagement to create customer-friendly interfaces.
- Have a clear plan for retaining ongoing access to appropriately skilled staff, within and outside the business.
- Tailor your procurement processes to support seamless handover with digital technology and service providers

Integrating with community

- Collaborate within and outside the business
- Explore new opportunities to interact with the community using digital technology
- Consider how, when and under which conditions to use and share you organisation's data. Some may generate revenue.
- Stay informed of and consider influencing regulations and standards.

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