DATA MONETIZATION: WATER AND WASTEWATER UTILITIES IN THE INFORMATION AGE

By Tal Avrahami | April 3, 2016

INTRODUCTION

Measuring the value of physical assets can be tricky. Valuation models for companies are arguably more art than science. What about the value of something nebulous such as data? The intrinsic value of data is nil. Data's extrinsic value is revealed only after processing it.

Once analyzing bits and bytes reveals patterns and anomalies, value creation happens by implementing systems, processes, and incentives that improve decision-making capabilities and performance. Data becomes extremely valuable once it can be leveraged to increase, or at least preserve, the value of assets and the companies that own them. Moreover, data can help make the people who comprise organizations far more productive and effective.

In this article, we will take a closer look at how water and wastewater utilities can monetize data and improve profitability by generating top-line growth and reducing costs.

CHALLENGES & OPPORTUNITIES

Ranging in size from serving a few dozen people to several million people, utilities operate centralized systems to collect, treat and deliver water, and subsequently, to collect, treat and discharge wastewater. We take it for granted that clean water flows as soon as we open the faucet and wastewater disappears out of sight down the drain or toilet. For many years, centralized utility systems have worked quite well. The overwhelming majority of people in the US and other developed nations have been able to depend on networks delivering safe, reliable drinking water supplies and handling wastewater for safe discharge to the environment.

But utilities now face significant and complex challenges: aging infrastructure leading to pipe bursts and significant water loss, service line corrosion leading to lead contamination, disinfection by-products creating chemical hazards, strained sewer capacity leading to overflow events, and water scarcity in drought-stricken regions to name a few. Within utilities' often sprawling networks of assets exist virtually infinite possible failure points. Waste and inefficiency have countless places to rear their ugly heads. Public and ecosystem health risks are spreading and becoming more acute.

Fortunately, these difficulties are surmountable or at least manageable. We will discuss how data collection can address these challenges in greater detail below, but first let us put data and knowledge into perspective.

KNOWLEDGE FRAMEWORK

Former US Secretary of Defense Donald Rumsfeld is credited with constructing a known-unknown categorization of knowledge.[1] This categorization provides a helpful framework for understanding knowledge and, by extension, the value of data:

1. Known knowns are the things that we know that we know.

2. Known unknowns are the things that we know that we do not know.

3. Unknown unknowns are the things that we do not know that we do not know.

By extension, the fourth category that Rumsfeld excluded is:

4. Unknown knowns, which are the things that we think we know, but do not actually know. Interpreted another way, unknown knowns are the things that we know, but refuse to acknowledge. Keep this second reading in mind.

Known Knowns

These are things that we know with great certainty – they are observable and measurable. These are the facts, rules, and laws. For example, water flows in the direction of gravity unless acted upon by an external force, say from a centrifugal pump. Water quality deteriorates as contaminant levels increase. If a customer's flow meter jumped from 50,000 to 100,000 gallons between monthly readings, then 50,000 gallons passed through the meter since during that month.

Image 1: Aerial view of Los Angeles aqueduct.

Known Unknowns

These are gaps in our knowledge that we know with great certainty exist. For example, a water utility knows it has experienced a main burst when it sends a field technician to confirm a report from a passerby of broken street pavement and gushing water. But the water utility in all likelihood does not know the specific cause of the burst. It likely also does not know how much water was lost to leaks prior to the burst or during the ensuing response period. Another illustrative example of this category is a wastewater utility experiencing combined sewer overflow (CSO) events during heavy precipitation. The wastewater utility knows these CSO events are bound to happen, but the operations team does not know when and where it will occur within the collection network.

Unknown Unknowns

These are the outliers or black swan events. We fail to recognize these things before they happen because of lack of or insufficient experience and imagination. Water and wastewater utilities use SCADA (supervisory control and data acquisition) systems to monitor and control pumps, valves, generators, blowers, and other assets within their networks. In 2014, the Department of Homeland Security investigated an incident at a wastewater treatment plant where a disgruntled employee deliberately caused an overflow by impermissibly accessing the utility's SCADA system.[2] This suspected sabotage could not be verified or tied to the employee in question by forensics investigators, as the plant did not have sufficient network monitoring and access information. This utility has likely removed this blind spot, but the utility managers could not have previously imagined this catastrophic scenario in their worst nightmares.

Unknown Knowns

These are the things we know, but do not like to know. Take for example rising sea levels and storm surges. We know with great scientific certainty that rising sea levels indicate a changing climate, and this phenomenon is a result of anthropogenic carbon emissions. We also know with a high degree of certainty that higher water levels make for more intense hurricanes and coastal storms. We also know with great certainty that these effects of climate change are escalating as carbon emissions continue to rise. In the face of this knowledge, we go about continuing to develop in high flood-risk areas and re-develop after massive flood events. Perverse policy incentives have encouraged property owners to rebuild in flood-prone areas. Insufficient investment has been funneled into flood mitigation and preparedness efforts. Although climate change seems like a distant threat, clear patterns have already emerged. With more than 120 million people in the US alone living in coastal cities or counties as of 2010 (a number expected to exceed 130 million by 2020),[3] the urgency and strategic significance of planning for the long-term cannot be overstated. Similar patterns exist across the globe. Certain climate model scenarios suggest that several hundred million people globally could be displaced by rising sea levels by the end of the century.[4] Massive migrations of people from unlivable coastal locations would be hugely disruptive to the global economy.

USING DATA COLLECTION TO CLOSE KNOWLEDGE GAPS AND ADDRESS CHALLENGES

Water and wastewater utilities appear to be facing a tipping point. The problems they confront have been increasing in number, severity, and complexity. As such, understanding and resolving to address these challenges should be rising in priority. A granular data-driven approach is paramount to effective and sustainable management of infrastructure and resources. Given the sheer number of factors at play and the often complicated interconnections between them, including feedback loops and time delays in cause and effect, common sense and a back-of-the-envelope approach will only take analysts and decision makers so far. Data fusion and analytics software tools capable of processing and correlating large volumes and different types of data can automate or facilitate insight extraction.

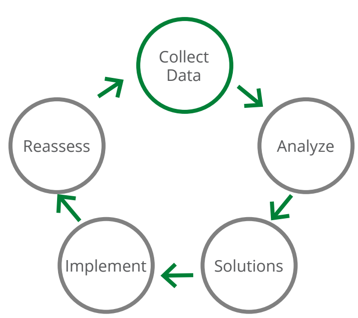

Image 2: Iterative data collection process.

> ***Data collection to close the known and unknown gaps of knowledge is the first and crucially important step water and wastewater utilities can take in the right direction.***

Where information is lacking in quality, quantity or is altogether missing, problems and bad decision making occur or persist. Data collection to close the known and unknown gaps of knowledge is the first and crucially important step water and wastewater utilities can take in the right direction. With baseline measurements of the state of their networks, operators can: evaluate problems, decide on and implement changes, and collect data continuously to assess results. This becomes an iterative process.

Utilities can maintain the status quo and languish. Or they can catapult themselves into the Information Age. The stakes could not be higher. Water and wastewater utilities are often public entities operating as monopolies – there are no competitors to fill the void of a failure.

While huge volumes of data are being created in virtually every industry, there is a surprising data gap in the water and wastewater sectors. Utilities oversee sprawling networks of distributed assets. Establishing and maintaining visibility within these networks has proved challenging to date. That need not be the case.

Aging Infrastructure & Underinvestment

Much of the infrastructure operated by water and wastewater utilities is aging and showing increased signs of vulnerability and rapid decline. In the US, many of the largest population centers are served by water treatment, distribution and conveyance, and collection systems that are several decades old. In some cases, these assets are more than a century old.

A combination of budget shortfalls, lack of political will, and lack of foresight in dealing with long-term challenges have translated into underinvestment. Meeting increased demand from a growing population and replacing or repairing dilapidated infrastructure will require massive capital expenditures and monumental efforts. According to analysis conducted by the US Environmental Protection Agency (EPA), utilities will need to invest $384 billion over the 20-year period between 2011 and 2030 to continue supplying a safe and reliable drinking water supply.[5]

In the US, water losses within distribution networks due to pipe and main leaks and bursts are estimated at more than 1 trillion gallons per year.[6] Water-stressed areas no longer have the luxury of accepting major water losses as a given part of doing business. California, which is experiencing an unprecedented multi-year drought, has passed landmark water loss legislation that requires all urban water systems to conduct water audits in accordance with American Water Works Association (AWWA) standards. Other states across the US are beginning to come to terms with the need for action and are pushing forward new water management policies. At the federal level, the Obama administration, in conjunction with the United Nations World Water Day, convened the White House Water Summit on March 22, 2016. The objective of the Summit was to bring water issues and potential solutions in the US to the fore, while helping to encourage fresh and innovative approaches through science and technology to sustain and secure the nation's water future.[7]

Much as doctors and nurses who screen and monitor patients for health issues take pulse and blood pressure measurements, utilities are setting up and expanding smart sensor networks to monitor the health of their networks. Pressure and flow data, among other parameters, can help operators identify and address problems in distribution and conveyance systems.

Freshwater utilities can pinpoint the sources of lost revenue from leaks, theft, and faulty meter readings. Campaigns to reduce this so-called non-revenue water (NRW) can help put billions of dollars of lost revenues back in utilities' coffers. NRW campaigns also reduce the associated costs of chemicals and energy for treating and delivering water.

Customers also benefit. Water tariffs have been rapidly increasing as a result of utilities contending with higher costs. Utilities can pass through savings to customers in the form of lower tariffs.

Operators can use powerful analytics tools to prioritize and optimize replacement and repair schedules. Predictive maintenance results in cost-avoidance by preventing infrastructure and equipment failures before they occur. The models and algorithms that make software tools powerful and effective depend on large volumes of high-quality data.

Reducing Energy Costs

Although water and energy systems have largely been developed, managed, and regulated independently, water and energy are highly interconnected. This interdependence is known as the water-energy nexus. Water is essential for power generation from thermo and hydro-electric plants and renewable energy sources. Water is also required for oil & gas production and coal mining. Similarly, energy is required to extract, treat, pump, and heat water. The water-energy nexus requires that utilities take a systems-based approach to holistic infrastructure network and resource management.

Energy is often a utility's largest or second-largest cost item after labor. For freshwater utilities, pumps that transport water through distribution and conveyance systems are the main drivers of energy use. Improper pressurization in pipes and mains is often an indicator of leaks, and over time can result in costly bursts. Data can aid in pressure optimization. This decreases pump energy consumption, reduces water losses and the likelihood of bursts, extends the useful lifetime of pumps, and reduces maintenance costs. Wastewater utilities can identify sources of infiltration that increase the volume of influent they must pump and treat, both of which are energy-intensive and thus costly. The lowest-cost energy is the energy that is not consumed. Identifying savings opportunities from energy efficiency begins with data collection.

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Public & Ecosystem Health

Aging infrastructure; improper and accidental discharge of industrial waste; agricultural runoff; disinfection byproducts; biological and chemical terrorism – all of these pose major threats to public and ecosystem health.

Mitigating these risks requires baseline measurements, trend analysis, and situational awareness. Decision makers, whether human or autonomous industrial control systems (ICS), need continuous data to respond effectively.

Environmental Change

Global environmental change is having profound impacts and manifests itself in varied manners at the local and regional level: heavier rains in some areas; severe droughts in others; rising sea levels; increasingly frequent and severe storms and flooding; salt intrusion; and more devastating forest fires. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report covers these topics in great detail.[8] These are all examples of impacts that utilities are contending with. Monitoring these trends with hard data is vital not only to improved long-term planning efforts, but also to improved operations when disaster strikes.

Regulations

Offering to citizens a high quality of life depends in large part on providing a safe and reliable water supply and properly collecting and treating wastewater prior to discharge or reuse. Managing public and ecosystem risks requires a strong policy foundation and solid regulatory oversight. Legacy policies based on bad decisions and political machinations are responsible for numerous failed and failing water and wastewater networks. With many public utilities operating as monopolies, competitive markets to promote self-regulation do not exist. Thus regulatory agencies play a vital role in ensuring desirable outcomes for customers and the environment.

The federal, state, county, and municipal governments are implementing new and more stringent regulations to respond to water network and environmental challenges. Effective policy-making and robust regulatory oversight at all levels of government require rigorous analysis and well-informed decision making, which in turn require solid data. Regulators are increasingly demanding that water and wastewater utilities address known challenges and begin to develop capabilities to adapt to change.

Avoiding hefty fines requires that utilities fill data gaps to improve day-to-day operations and long-term planning. A single instance of pollution, for example, can lead to hundreds of thousands of dollars in fines. Cost-effective data collection to prevent or contain events has huge returns on investment.

INDUSTRIAL AUTOMATION

Water and wastewater utilities are notoriously risk-averse and have taken a conservative approach to implementing and replacing industrial control and process automation technology. Financial pressures and funding mechanisms, utility governance and culture, regulatory frameworks, and infrastructure condition and performance, among other factors, have created barriers to innovation.

Utilities long ago learned to mechanize processes to significantly scale throughput. They introduced technologies that improved upon previous approaches and techniques. When problems arose, a patchwork approach to solving them was sufficient. When pipes leaked, new lines were installed. When spills occurred, they were largely ignored. For decades, this approach worked well enough.

But managing the scope and complexity of today's water and wastewater networks, coping with a changing climate and growing populations, and navigating the evolving regulatory frameworks that govern them requires that utilities take a new approach.

In a 2011 essay published in the Wall Street Journal, investor Marc Andreessen wrote, "software is eating the world."[9] The premise of his thesis was this: computers, microprocessors, and the modern Internet have been developed and improved over the past few decades. Collectively, these technologies now function at levels of sophistication and economies of scale to run businesses and industries on software and to deliver them in the form of online services.

This trend has played out across consumer, healthcare, transportation, education, and dozens of other industries. Drinking water obviously cannot be replaced by a virtual substitute in the way that streaming services can substitute for DVDs and ride-sharing applications can eliminate the need for vehicle ownership. But the industrial sector, including water and wastewater utilities, are now in the early innings of a similar digital evolution. This evolution also combines new innovations in sensor and communications technologies that is collectively being referred to as the Internet of Things (IoT) or the Industrial Internet of Things (IIoT).

Remote monitoring and industrial automation are the best and most impactful means for efficiently and cost-effectively improving network and resource management. Machine-to-machine communication offers utilities large and small alike the opportunity to collect the data needed to identify the known and unknown challenges and opportunities for improvement. SCADA systems and other data analytics and fusion platforms can far outperform human capabilities in correlating many sources of data on various parameters. Software tools are capable of developing stochastic models to predict the likelihood of disruptive events before they occur. SCADA systems can effectively control assets in ways that improve infrastructure and resource management in ways not previously conceivable.

Large volumes of high-quality data are the feedstock of effective ICS. Improved data acquisition capabilities will help utilities move more seamlessly into the Information Age. As this industry evolves and is eaten by software, cyber threats become more salient.

A FEW WORDS ON CYBER-SECURITY

Water and wastewater networks are critical infrastructure – they are essential to the health, safety, and prosperity of people and economies. As water and wastewater utilities become increasingly dependent upon software and ICS, ensuring the cyber-security of their information technology infrastructure is tantamount to ensuring the security of their physical infrastructure, the public, and the environment. SCADA

Image 3: Cyber-security for data centers is vital.

systems and other ICS that leverage data gathered from remote monitoring systems are only as secure as the weakest link in the network.

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Remote monitoring systems offer would-be malicious hackers a reverse entry-point into sensitive databases and ICS. Measures needed to reduce the attack surface size for infiltration include: using secure communication protocols, encrypting data, and identifying sensor and gateway tampering.

Progressive utilities that use sensors to create data collection nodes throughout their network are at an advantage relative to those utilities that collect little or no data at all. But utilities that understand the importance of securing their SCADA systems and ICS are truly forward-thinking.

CONCLUSIONS

We have articulated numerous ideas at length. First, data is only valuable once processing it reveals insights and action is taken. Second, water and wastewater utilities face a variety of challenges; their knowledge gaps can be categorized into a known-unknown matrix. Third, smart sensor networks that gather continuous data enable utilities to boost their top-line and reduce costs. Fourth, water and wastewater utilities are at the early stages of a major shift into the Information Age. Fifth, industrial automation has great promise to improve network and resource management. Sixth, cyber-security threats are real and must be addressed to protect critical infrastructure, the public, and natural ecosystems.

Utilities can monetize data and realize rapid and outsized returns on investment using turnkey, cyber-secure, cost-effective data acquisition solutions. Water and wastewater utilities that understand this opportunity and capitalize on it will lead their sectors into a more resilient and prosperous future.

Image 4: Field installation of Ayyeka Wavelet Ultrasonic CSO Kit for sewer level data acquisition in Cincinnati.

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