Exciting future for big data solutions

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discuss the drivers and barriers to the adoption of smart city initiatives as well as the role of entrepreneurial startups in advancing and commercializing cloud-based, big data solutions to increase efficiency and sustainability.

Smart water infrastructure and big data are starting to attract funding both from investors and utilities after years of capturing the water sector's imagination. Automated Meter Reading (AMR) and Advanced Metering Infrastructure (AMI) have been around for decades, but improved sensors, advanced analytics, and visualization tools are now enabling utilities to better partner and interact with their customers.

Smart water infrastructure technology has the potential to reform delivery of services while raising the quality of life by helping to make cities more sustainable and resilient. Cloud-based platforms offer the potential for implementation of these big data solutions at utilities of all sizes. Small investments in hardware and software are required for cloud-based computing that align well with the resource constraints of small- and medium-sized utilities. The smart city movement encompasses many facets, such as smart buildings, energy management, transportation connectivity, information connectivity high speed data networks, and, of course, water management.

Opportunities from smart city programs are exciting to contemplate, but two factors really serve as the primary drivers for a city or community to implement smart city initiatives – achieving cost efficiency and sustainability. According to the survey conducted to develop the "Black & Veatch 2016 Strategic Directions Smart City/Smart Utility Report," the ability to improve efficiency of operations or reduce cost was the most important driver, while environmental or resource sustainability was the second. These two factors combined for more than 50 percent of the responses. Interestingly, in just a little over a year, the efficiency driver decreased from 42 percent to 30 percent, while the sustainability factor nearly doubled from 11 percent to 20 percent between surveys conducted in 2014 and 2015.

Another notable change was that the importance of the ability to attract business investment increased considerably to 8 percent. The change in focus seems to indicate some welcome consideration of a longer-term decision making horizon. The expected long-term focus is also indicated in the expected timeframe for widespread adoption of smart practices. In 2014, nearly 20 percent of respondents expected widespread adoption within 5 years, and half the respondents expected it within the next decade. The 2015 survey tempered expectations, with only 8 percent of respondents expecting widespread adoption within 5 years and the majority expecting a 6- to 15-year timeframe.

From a utility perspective, the leading drivers are a strong business case or return on investment (ROI) and an assessment of the potential benefits of smart programs, each with about 40 percent of the responses. In terms of actual implementation, water utilities trail natural gas and electric utilities in the implementation of smart initiatives. About a third of all natural gas utilities and one quarter of all electric utilities report being engaged in a smart city initiative, while only 15 percent of water utilities claim to be.

Focusing specifically on the water sector, a companion study to the smart city report, the "Black & Veatch 2015 Strategic Directions US Water Industry Report" showed that nearly half of the water utilities are not participating in smart city initiatives, while nearly 4 in 10 of the respondents reported not knowing if they were participating, suggesting that water systems might be left out of the conversation or, at the very least, lack clarity about the water roles in a smart city.

While smart water practices are increasing in adoption, the barriers to implementation in the water sector are generally well known and include siloed communication within the utility and between infrastructure sectors, the need to justify ROI, lack of budget, and lack of resources and expertise. Additionally, at the municipal level, sometimes short-term, high-visibility smart infrastructure projects such as street lights, digital kiosks, and electric vehicle charging systems may gain funding approval more easily than water-related initiatives. Master planning efforts to integrate water, energy, communications, and transportation systems are complex and come with a longer time horizon, which might make them comparatively more difficult for decision makers.

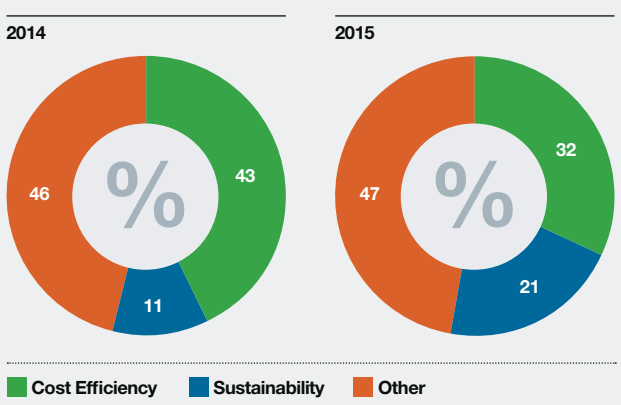
One critical way to encourage adoption of smart infrastructure practices is through citizen engagement. Intelligent metering and data analytics allow utilities to change the dynamic of customer communication and education about individual water consumption. Any smart utility plan and its efficiency and reliability gains must be effectively explained to citizens. A challenge facing water providers is the need to demonstrate to stakeholders the dangers of delaying advances, which may only exacerbate the problems facing the sector such as drought, aging infrastructure, and outdated equipment.

The Nutrient Sensor Challenge exemplifies one effort to advance sensor technology.

Big data opportunities

As more and more utilities implement smart water practices, the opportunities to harness big data are growing rapidly. In March 2016, Imagine H2O announced the winners of its Water Data Challenge competition. These innovative startup companies provide an indicator of the momentum toward providing big data solutions. While water and many other resources have been called "the new oil," big data has earned this cliché moniker for nearly a decade as well. The big data analogy to oil is quite appropriate since oil has little value in its raw form, but when refined, it can power the world. The same

Figure 1: Primary Driver for Smart Infrastructure Programs



Source: Adapted from Black & Veach 2016 Strategic Directions Smart City/ Smart Utility Report

can be said of big data. The water sector has a huge amount of data, but that data must be refined into information to spur utilities and customers to knowingly take action.

Utilities implementing smart water practices must consider six key aspects of a big data platform: integration, analytics, visualization, development, workload optimization, and security and governance. Integration is critical to have one platform managing the data, as separate silos of data only create separate silos of insight. An integrated solution has to be bigger than one technology. Analytics tools are used to analyze the data, providing more sophisticated, accurate, and actionable information. Visualization tools bring the information into a form that is understandable by decision makers, be they utility managers, government officials, or customers. Development tools are needed to enhance the analytical and visualization engines as well as support the overall platform. Workload optimization focuses on efficient processing and storage of the data. Security and governance are critical for maintaining the sensitive data that must be protected, which is especially important for public sector agencies including many water utilities.

Sensors are one of the biggest sources of big data, and the water sector is particularly rich in sensor data. Smart metering, inventory management and asset tracking, fleet management, SCADA systems, and water quality instrumentation are major sources of sensor data.

The Nutrient Sensor Challenge exemplifies one effort to advance sensor technology. The Challenge is an innovation effort to accelerate the market for the development, adoption, and use of sensors to measure nitrate and orthophosphate in water. The goal is to encourage development of sensors that are affordable (less than US$5,000 purchase price), reliable (unattended operation for 3 months), and can provide accurate real-time data. The Challenge, which seeks to accelerate these new technologies to commercial availability by 2017, is being sponsored by Alliance for Coastal Technologies (ACT). ACT is a partnership of research institutions, state and regional resource managers, and private sector companies, supported by US National Oceanic and Atmospheric Administration (NOAA) and Environmental Protection Agency funding, whose purpose is to develop, improve, and apply sensor technologies to study and monitor coastal environments.

Private investment from venture capital firms are helping companies that provide solutions associated with many aspects of big data platforms to advance at a rapid rate. For example, XPV Water Partners (Canada), one of the world's leading institutional water funds, counts the US firm FATHOM as one of their portfolio companies. Based in Phoenix, Arizona, FATHOM is a software-as-a-service, cloud-based, geospatial data integration platform helping to enable water utilities of all sizes to unlock the power of their meter and customer data in order to increase revenue, decrease costs, and delight customers. Emerald Technology Ventures (Switzerland) recently invested in Optimatics, an Australian firm providing infrastructure planning software that uses genetic algorithms to optimize capital investment for water and wastewater utilities.

Imagine H2O, a global water innovation accelerator, conducts water infrastructure challenges that produce companies advancing technologies for analytics, sensors, and visualization. From the analytics arena, 2015 winner Valor Water (San Francisco, California, USA) provides customer sales analytics software to water utilities to address revenue risk, affordability, and supply management. Finalists included FLOWatch (Wynnewood, Pennsylvania, USA), which provides integrated asset management software for water and environmental systems operators, and Dropcountr (Redwood City, California, USA), who uses data analytics and mobile apps to communicate water usage and metrics to consumers and utility staff. On the topic of sensors, finalist Lumense (Atlanta, Georgia, USA) is developing a real-time, continuous sensor platform for monitoring chemicals and biologicals in water, while fellow finalist Aquarius Spectrum (Israel) features a near real-time, automatic water pipe monitoring tool for leak detection based on acoustic sensing.

Like Imagine H2O, The BREW accelerator program at the Water Council in Milwaukee, Wisconsin, USA has seen an increase in big data-related participants from

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Industry shifts to smarter water approach

Carey Hidaka of IBM Analytics, Safer Planet explains how Smarter Water Management techniques can improve operational efficiencies in the water industry.

The water and wastewater industry is currently in transition from business-as-usual operations, employing traditional engineering solutions, to a new approach – Smarter Water Management – which uses big data and advanced analytics to create new insights that can improve operational efficiencies. Smarter water projects occupy the full breadth of water-related, ranging from front-end water resource management to drinking water treatment and distribution systems to wastewater systems that collect, treat, and return effluent to the environment. Three projects presented below illustrate how Smarter water management is a catalyst in addressing water industry challenges in water resource management, drinking water distribution, and wastewater management.

The Jefferson Project at Lake George, New York, United States is a water resource management project that is using smarter water techniques to gain a thorough understanding of the lake's current water quality. The partnership, consisting of Rensselaer Polytechnic Institute, IBM, and the FUND for Lake George, will use environmental data from Lake George to understand and manage the complex set of factors, including road salt, stormwater runoff, and invasive species, that threaten one of the world's most pristine natural ecosystems. This analysis encourages proactive management of water as an increasingly scarce natural resource. The project uses a combination of advanced data analytics, computing, and data visualization techniques; new scientific and experimental methods; and 3-D computer modeling and simulation as well as historical data that is producing an unprecedented scientific understanding of Lake George to enable scientists to set priorities and act before permanent degradation can occur.

In India, the Bangalore Water Supply and Sewerage Board (BWSSB) uses data to address the critical issue of equitable drinking water distribution in an area of the world battling water scarcity. BWSSB supplies water to nearly 800 square kilometers of Bangalore, and the use of big data and predictive analytics created systems for monitoring and managing its increasingly complex water distribution system. Surface water sources can no longer meet Bangalore's water demand, leading to a formidable challenge in the equitable distribution of available water among the city's population. As a result, Bangalore's Smarter Water project has created operational tools based on BWSSB's available system data that support monitoring, administering, and managing Bangalore's water supply networks. These tools assist BWSSB in assessing water supply at any point in time, and when operating goals are not met, real-time alarms allow engineers and operators to make quick, informed decisions to support the goal of equitable water distribution.

IBM Research, working in partnership with a European wastewater utility, developed an end-to-end water resource recovery plant optimization that can save as much as 15 percent or more of costs associated with energy consumption, biosolids handling, and chemical usage. Using a big data approach that integrates dynamic plant simulation forecasting and mathematical optimization, activated sludge treatment processes can be significantly improved in the areas of resources recovery, cost efficiency, and regulatory compliance.

These smarter water project examples are representative of a growing shift in the industry toward innovative and cost-effective solutions. Water and wastewater utilities need to implement these solutions to solve the significant challenges dominating the industry, ranging from crumbling infrastructure, growing populations, drought, and climate change.

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Samples of the groundwater exiting the resort from the sand at the low-water mark showed low Total Organic Nitrogen (0.57 mg TON/L) and nitrate levels (1.6 mgNO3-/L), well within the Fijian standard for environmentally sensitive areas (TON < 10 mg/L).

The low nitrogen levels in the groundwater entering the reef was attributed as the major cause of the recession of the algal bloom at the low-tide level and the regeneration of the reef seen during the nine-month period following the commissioning of the BioGill treatment system.

A report compiled after nine months in operation showed no sign of membrane fouling or deterioration and no decrease in treatment performance consistent with all other BioGill systems operated so far. The findings demonstrate that the technology is simple, reliable, and economical, given its energy consumption rate of 1 kWh/m³ of treated effluent. The simplicity of operation and maintenance makes this technology suitable for remote sites and developing nations without the need for skilled staff to operate the system.

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the city. The most recent class included Optiktechnik, which makes laser-based, optical sensors and instrumentation to improve monitoring and control of key particle processes in water and wastewater treatment. Radom creates instrumentation to identify toxic trace metals in water, wastewater, industrial processes, and food and drugs. Current Data is a watershed-focused water quality data collection and information system using a sensor array and mobile app with cloud storage and analysis tools to lower the costs of data collection and increase its use in critical water quality decisions. In the BREW's inaugural class, Meter Hero focused on water consumption data and social networking to drive conservation programs.

Drinking water and wastewater are not the only categories of water sector advances in big data. On the groundwater front, Wellntel, provides a real-time understanding of well and surrounding water table dynamics, provided through constant measuring and reporting of water levels. Both Imagine H2O and the Water Council's BREW program recognized this firm for its innovation. Managing stormwater in real time is the focus of both EmNet and OptiRTC, while companies like H2Ometrics provide cloud-based visualization tools to better plan stormwater and sewer operations.

Cloud-based solutions provided by innovators will help water utilities of all sizes advance smart water infrastructure. Smart water innovation has even emerged from firms better known for other IT sectors such as network giant CISCO or mobile devices leader Qualcomm. With innovations developed by entrepreneurial startups and large companies including IBM, GE, and OSIsoft, an exciting future is already underway for big data solutions in smart water infrastructure.

Authors' Note

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