Digital Disruption in the Water Utility Value Chain

Executive Summary

The water utilities industry is quickly evolving to meet the demands of a dynamic, highly deregulated and competitive market. Climate changes are generating water shortages and altering flood patterns. Global warming is giving rise to extreme weather conditions - causing urban water supplies to dry down. Infrastructure issues and droughts only add to these concerns. Performing long-term impact assessments and managing ecosystems to monitor resource extraction, industrial use, and consumption are no longer optional.

In response, water utilities continue to navigate the unsteady path to transformation. Change management has become a daily task rather than a one-time activity, compelling companies to respond and adapt quickly to new business and technology requirements.

Yet along with these challenges come opportunities. Globally, utilities are the beneficiaries of advances in digital technology and analytics. Some of these (predictive analytics; machine learning and artificial intelligence; unstructured data analytics; video and thermal imagery from drones; cognitive computing; robotics; the Internet of Things; and blockchain) can resolve many of the problems facing water utilities. The key is to identify and segment issues, and develop scenarios to overcome them. (See Figure 1, next page).
DIGITAL DISRUPTORS

Conserving treated water in whatever form remains a critical issue. Digital technologies can play a major role in helping the water utility market reduce constraints moving forward. Figure 2 highlights digital advancements that can enhance the water value chain and help conserve this critical natural resource.

Digital Disruptors that Reduce Market Constraints
### QUICK TAKE

#### Water Utility Business Challenges

<table>
<thead>
<tr>
<th>Challenge</th>
<th>How Digital Technology Can Help</th>
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<tr>
<td>Demand Forecasting, Asset Failure</td>
<td>• Machine learning improves the accuracy of weather-related data, the impact on resources, and the predictions of asset failure.</td>
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<tr>
<td>Aging Infrastructure</td>
<td>• Robotics and big data analytics help assess the condition of the waste water pipeline.</td>
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<td>Non-Revenue Water</td>
<td>• Artificial intelligence-based quantitative risk modeling can perform pipeline risk assessments and rehabilitation.</td>
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<td>Asset Health Monitoring</td>
<td>• Drones-based inspection and LiDAR data analytics improve productivity by executing tasks faster and more accurately.</td>
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<td>Electricity Consumption &amp; Cost Optimization in Water treatment</td>
<td>• Smart sensors installed on the network improve data visibility through the Industrial Internet of Things (IIoT).</td>
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<td>Contracts &amp; Billing</td>
<td>• Blockchain concepts for smart contracts and billing reconciliation improve auditability and traceability.</td>
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<tr>
<td>Customer Consumption &amp; Billing Patterns</td>
<td>• Outlier analysis based on cluster algorithms and big data analytics help uncover anomalies in consumption and billing.</td>
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<tr>
<td>Water Production Planning</td>
<td>• Cognitive-based situational intelligence helps optimize water production planning.</td>
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Machine Learning

As global warming becomes more prevalent, extreme weather conditions are a common occurrence across the globe. Given the part that weather-related data plays in monitoring and managing the water supply chain, it is more important than ever to accurately predict water shortages, track flood patterns, and identify asset failures early on. Machine learning can play a crucial role here.

Machine learning adapts to changing conditions using real-time information gathered from historical data. The accuracy of the information - and resulting decisions - improve with each weather event/scenario. Predictions concerning weather patterns, floods, droughts, and asset failures are thus more reliable because the impact of weather on field assets is continually analyzed in real time.

Robotics & Big Data for Assessing & Rehabilitating Waste Water Pipelines

Robotics-based process automation is applied across the utility industry to eliminate manually intensive, repetitive activities and address hazardous conditions. Tasks that are prone to human error and accidents can now be performed by robotics solutions reliably and accurately. Robotic sensors embedded with artificial intelligence and equipped with “smart” pipeline inspection gauges, or pigs, run inside waste water pipelines, using video and big data to capture, analyze, and report the condition of these structures, as well as potential hazards, in real time. (See Figure 4).
Drone Inspections & LiDAR Analytics

Utility companies use drones to inspect areas of their network that are difficult to access during manual inspections. In the case of water utilities, drones can fly in dense forest regions that are hard to penetrate during harsh weather conditions – recording data for pipeline inspections as well as thermal/laser imagery data captured over time. By overlaying this imagery with time-series analysis of structural conditions, utilities can gain deeper insight into their business and technology operations, and initiate proactive maintenance and operational activities to increase the longevity of their distribution network.

Modern drones are equipped with analytics that can handle large gigabytes of video and imagery data, which is then integrated with enterprise-level collaboration and content management systems to manage unstructured data on big data platforms.

The Industrial Internet of Things

The Industrial Internet of Things (IIoT) opens huge opportunities for water utilities in the form of connected devices, human resources, and networks. In water and waste water treatment, reducing electricity consumption is a major cost saver. The granular data collected from water and waste water treatment plants can be of even greater value if the right sensors are installed on the network. By combining data from real-time IoT platforms with predictive analytics, data variables can be monitored, tracked, and analyzed easily to make informed decisions. (See Figure 5 above).

Monitoring pump performance is another area where the IIoT can help by tracking the performance of pumps and their operational characteristics more efficiently – leading to more accurate failure predictions and proactive maintenance to assure asset longevity. Today’s IIoT devices are also used to help monitor water quality at various consumer end points in the network.

Artificial Intelligence for Risk Modeling, Risk Assessment & Rehabilitation

Artificial intelligence (AI) self-learning techniques are increasingly used by water utilities to assess and resolve equipment-related issues, including those in the pipeline. In these cases, AI algorithms...
assess pipeline risk. Various factors – static and dynamic alike – affect the condition of pipes, which are vulnerable to geographic, environmental, weather, structural, and internal conditions. Until recently, statistical modeling techniques were used to develop predictive risk models. With the advent of artificial intelligence algorithms, the accuracy of predictions has increased dramatically due to the algorithms’ self-learning capabilities. With every pipeline failure, risk modeling methods and their impact are assessed and tuned to better predict future incidents.

Artificial Intelligence is further enhanced by the integration of multiple organizational systems and the use of unstructured data to train models. Drone imagery is an excellent example. Imagery captured by drones is assessed in tandem with the statistical risk models to gauge the actual condition of an asset. The unstructured data analysis validates the theoretical model, which then trains itself.

Another important factor is surge from internal water pressure variations, usually due to pump operations and valves in the transmission and distribution network. Given that pressure surge is the main cause of water leaks in water pipelines, using artificial intelligence algorithms and models to accurately predict surges will go a long way in reducing water leaks. (See Figure 6).

**Cognitive Computing for Optimizing Water Production Planning**

Water production planning is a critical function in the water utilities value chain – requiring companies to comply with all licensing and statutory obligations while balancing risk, capacity, and costs. Given the increasingly competitive landscape, optimizing production planning is no longer arbitrary; it's a key strategic advantage. The amount of water treated and the timing of the treatment have an associated cost impact. On the demand side, variations in consumer demands and treated water storage capacities must be verified. On the supply side, there should be ample visibility into the amount of water that can be extracted within the limits set by regulatory authorities and the capacity of alternative water sources. The overall goal is to ensure ample supply at the least cost.

Among the key challenges in water production planning is the lack of telemetry data and real-
time information on output flows, variations in storage capacity, unit cost metrics, chemical consumptions and operational timing of pumps.

Efficient production systems depend heavily on data collection, modeling, visualization, and situational intelligence from cognitive computing to overcome these issues. (See Figure 7). Cognitive computing in water production planning uses real-time data and analytics to gather, sort, and analyze data in a comprehensive and holistic way.

**Big Data**

On the retail side of the water value chain, “clustering algorithms” are proving useful in finding the root cause of discrepancies in consumption, metering, and billing. Outlier analysis focuses on comparing retail/industrial customers with common attributes (location; class; size of property; number of residents; annual income level; credit score; and historic average consumption) to analyze and compare usage patterns. Analyses enabled by big data can highlight many of the discrepancies that traditionally exist in billing and metering.

**Blockchain: A trusted ledger for transactional data**

Blockchain algorithms and structures, initially developed to trade digital currencies in the financial services world, are increasingly used in applications for the water utility industry. Blockchain technology maintains a distributed public ledger for different types of industry transactions. Since all industry parties share a public view of the blockchain register, the register’s data can serve as a trusted source for multiple market participants in areas such as carbon footprints, smart contracts, metered consumption, settlements, and billing reconciliations.

*Cognitive Computing & Water Production Planning*

![Figure 7](image-url)
A GOVERNANCE FRAMEWORK FOR DIGITAL TRANSFORMATION

Digital transformation obliges companies to engage all stakeholders and project implementation teams. When prioritizing digital projects, water utilities should consider the business value and long-term benefits of digitization.

Assessing digital maturity requires a clearly defined vision, strategy, and roadmap, plus a supporting organizational structure and framework. (See Figure 8).

- **Digital vision, strategy & roadmap**: This phase focuses on where the organization is headed, its short and long-term vision, the expected benefits, and what the business will look like over time – with clearly stated milestones and associated returns. This high-level view will define and guide subsequent activities of digital implementations.

- **Digital organizational structure**: Successful digital initiatives require companies to restructure their operating environment. Maintaining a longer-term perspective always yields better results than attempting to implement shorter, more drastic changes. Industry best practices indicate that digital organizational structures call for innovative office setups and specific roles, including chief digital officer, digital strategist, and digital ambassador. Digital environments depend on digital champions and officers to prioritize and run digital transformation projects. Adequate authority, roles, and responsibilities should be in place to inform and improve decision making.

- **Digital processes**: Business processes need to align with digital initiatives. Increasingly, Agile and DevOps-based methodologies are moving into mainstream implementations projects. Quick prototyping and sprint-based delivery cycles can deliver benefits to customers faster during short development cycles.

- **Digital competency framework**: Water utility companies must equip their employees – from the front office to the field – with the skills and responsibilities they need to enable a seamless digital transformation. Frameworks for identifying knowl-
edge and skill sets within the organization should be identified and mapped accordingly.

- **Digital opportunity evaluation:** Water utilities should create frameworks and procedures for gauging digital opportunities. A solid business case that articulates and prioritizes these initiatives must be in place. Goals such as improving the end user experience, increasing return on investment, and making the best use of resources, skills, and budgets can be the basis for targeting opportunities in a digital environment. (See Figure 9).

**Targeting Opportunities in a Digital Environment**
## QUICK TAKE

Prioritizing opportunities can be as simple as an m X n matrix, which factors in such things as ease of implementation and business impact. (See Figure 9). Opportunities associated with digital business are evaluated against criteria such as alignment with the business strategy, availability of resources, and skills, and budget constraints. Opportunities with the highest potential for delivering the most business value can be measured against profit / revenue generation. Ease of implementation can be gauged by the level of difficulty and complexity, and the amount of effort required by human resources.

Digital initiatives must be evaluated and prioritized from various aspects.

<table>
<thead>
<tr>
<th>Business Value (BV) Evaluation criteria</th>
<th>Ease of Implementation (EI) Evaluation criteria</th>
<th>Priority</th>
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<tbody>
<tr>
<td>• Alignment with overall business strategy</td>
<td>• Difficulty of technology rollouts</td>
<td>• High - if both BV and EI are high</td>
</tr>
<tr>
<td>• Effort to effect business change</td>
<td>• Complexity of customization</td>
<td>• Medium - if either BV or EI are low</td>
</tr>
<tr>
<td>• Filling skills &amp; competency gaps</td>
<td>• Duration of the project</td>
<td>• Low - if both BV and EI are low</td>
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<tr>
<td>• Return on investment</td>
<td>• Stability of the technology platforms</td>
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GETTING THERE FROM HERE

Digital disruption in the water value chain is fast becoming a reality. Sooner than later, water utilities worldwide will make the shift to digital technologies. At the same time, there will be challenges in terms of adoption; cultural and organizational changes; managing data; processes; and infrastructure. Evaluating and identifying the appropriate digital initiatives for your company will depend on your industry’s value chain, understanding associated business challenges, and addressing bottlenecks that may stand in the way. Sustaining these initiatives calls for specialized capabilities, a proven process framework, solid implementation methodologies, and a carefully defined vision, strategy, and roadmap.

Water utilities that transform to digital business will be more agile, and responsive to the demands of a dynamic marketplace. Productivity improvements alone will allow them to stay in step with regulatory and licensing standards, optimize costs, and streamline processes within and beyond the business.

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