White paper

The Business Case For Digital Twins - Part 1

A catalyst for efficiency, innovation, and resilience

Prepared for **Bentley Systems** by **earthfinance**
Authors: **Benjamin Ma, Camillus Fitzpatrick, Will Sarni**

1.0 Executive summary

Digital twin technology is emerging as a disruptive innovation in modern infrastructure management, revolutionizing the way that systems are monitored, analyzed, and optimized. The core value proposition of digital twins lies in their ability to synchronize real-world sensor data with advanced simulation engines, creating living models that enable predictive optimization of operational parameters, such as energy and water consumption. By creating dynamic, data-driven virtual replicas of physical assets, systems, and processes, digital twins provide meaningful insight into operational performance and environmental impact through optimized resource flow, energy efficiency, and systems resilience.

Numerous global factors are driving the necessity for economic transformation through digital twins. Heightened exposure to physical risks (including natural disasters, infrastructural damage, and other factors) and evolving risks (regulatory, market, and technology changes) accelerate the urgency for businesses to not only sustainably secure natural resources, but also engage in material reuse, recycling, and closed-loop production. Within the context of increasing demand for water, aging and underinvestment in infrastructure—as well as the dynamics of the utility workforce business and public utilities—can look to digital twins as a tool that enhances business resilience, supplement human expertise, and accelerates operational and strategic growth.[1] Findings from our research reveal that, across the world, the value of digital twins is clear and extends beyond long-term efficiency and productivity gains. They empower decision-making, uncover hidden inefficiencies, and unlock new revenue opportunities across various industries.

1.1 Paper objectives

This paper is the first in a two-part series and examines how digital twins can be deployed to facilitate water-resilient economic practices across public and private sectors, with a particular focus on utilities and related industries that are increasingly exposed to water stress and aging infrastructure in need of digital solutions. Additionally, it draws on qualitative insights from structured interviews with industry stakeholders across North America, Southeast Asia, Europe, and Latin America. These diverse regional perspectives reveal important variations in regulatory frameworks, technological adoption rates, and cultural approaches to water management that impact digital twin implementation strategies. Participants included executives, policymakers, and technical experts from water utilities and related industries, offering diverse perspectives on digital twin adoption. Combined with academic research, industry case studies, and global best practices, the document outlines a roadmap for leveraging digital twin technology to optimize resource efficiency, reduce waste, unlock new business model opportunities, and integrate digital transformation governance into existing corporate decision-making frameworks.

The research for this white paper comprised the following:

- Surveying digital twin applications across industries and organizations, with a specific focus on their role in enabling water-resilient economic practices.
- Highlighting opportunities to integrate water resilience and resource reuse principles with data-led decision-making tools, showcasing how digital twins can be leveraged to optimize resource utilization, reduce waste, and create new value streams.
- Examining the role of software and infrastructure players in digital twin adoption, addressing key organizational challenges, and helping businesses achieve operational success and environmental stewardship goals.

1.2 Summary findings

The findings in this paper are a culmination of a review of academic literature, industry research, and case studies, as well as semi-structured interviews with business leaders and digital twin users. Stakeholder interviews with 13 global experts engaged with the water utility and infrastructure sectors across North America, Latin America, Europe, and Asia-Pacific reveal **10 key takeaways** and implications for the adoption of digital twin technologies.

1. **The current development of digital twins is not primarily driven by environmental stewardship goals.** The focus, instead, is on creating business value through cost reduction, resource and infrastructure management, and efficiency optimization.
2. **Improved efficiency, a prolonged lifetime of objects or systems, and increased customer satisfaction are among the top benefits of digital twin adoption.** The operational savings, efficiency gains, and predictive power of digital twins can translate into long-term financial returns for businesses and utilities.
3. **Artificial intelligence (AI) has significant potential in enabling digital twins to drive a water-resilient economy.** Digital twins represent the convergence point where AI, the Internet of Things (IoT), and advanced analytics meet infrastructure management. AI integration can enable digital twins to go beyond mirroring its physical twin and ultimately operate as a dynamic, agile hub to process data, gather insights, and generate predictive maintenance strategies that transcend traditional efficiency gains.
4. **Digital twins enhance rather than replace human decision-making.** They amplify expertise by providing data-driven insights and operational intelligence. Ultimately, such technologies are used as a data visualization tool to empower human expertise. Closing the skills and technology literacy gap requires workforce development training on data literacy, systems integration, and gaining hands-on experience in a virtual environment before applying skills in the real world. Doing so would not only enhance existing workforce skills, but also retain top talent in an increasingly critical industry.
5. **Digital twins fundamentally mitigate risk, not amplify it.** Sectors such as energy and water utilities are hesitant to adopt digital twins because their services are critical to end-consumers from a public safety lens. However, digital twin technology can simulate future scenarios, such as natural disasters or pipe breaks, visualizing potential vulnerabilities as part of protecting communities they serve.
6. **Innovation happens at the leadership level.** Whether in the policy or corporate sphere, success hinges on having influential champions who can bridge the gap between innovation teams with limited decision-making power and leaders with greater decision-making power. Innovation reinforces a culture of learning.
7. **New business governance frameworks should factor technology innovation.** Incremental budgeting and capital allocation for innovative technologies can help prepare businesses for future change while minimizing investment risks.
8. Accurate, precise, and unbiased data is critical for maximizing the value of digital twins, **but perfect data is not necessary from the start.** Many organizations struggle to convert abundant data into actionable insights. Although data quality has been historically difficult to achieve, users continue to see the benefits of digital twins. This trend represents an opportunity to start small, scale data volume, and strengthen predictive power over time as data collection, integration, and interoperability continues to improve.
9. **There are significant limitations to data interoperability.** The lack of consistent and agreed-upon standards being applied to quality, format, and nomenclature limits users' abilities to connect, control, and synthesize disparate data sources.
10. Collaborative initiatives, such as bringing together stakeholders and forming communities of practice, **could significantly contribute to knowledge sharing and capacity building.** Facilitating networks that promote the exchange of ideas and expertise can assist learning and growth. This is particularly true for smaller organizations.

1.3 The economic growth opportunity: What is the business case for digital twin adoption?

Digital twin technology has emerged as an enabler for corporations to capture value in the fast-growing water-resilient economy that is projected to reach USD 5 trillion globally by 2030.[2] Such technologies can streamline operations, enhance customer experiences, and accelerate efficiency measures that reduce energy, water, and greenhouse gas emissions across corporate value chains.

At large, digital twins mitigate risk and enable adaptation for capital-intensive, asset-heavy industries. When updated with real-time sensor data, they identify operational bottlenecks and provide scenario analysis to empower rapid decision-making. More importantly, digital twins offer a promising solution to essential economic sectors, such as the manufacturing, chemical, water and energy utility, and other risk adverse sectors.[3] Digital twins deliver significant value when organizational silos are dismantled and relevant enterprise data is integrated. Integrating historically isolated data and legacy systems is important for improving the accuracy of digital twin forecasts related to system performance, maintenance needs, and operational efficiency.[4]

What is the market suggesting?
The market for digital twin technology is expected to surpass global revenues of USD 379 billion by 2034, which is an increase from USD 35 billion in 2024.[5] Early adopters across the manufacturing, energy, and infrastructure sectors are achieving 19% to 34% reductions in operational costs while unlocking new revenue streams through product-as-a-service models and material recovery marketplaces. Market analysis indicates the global market for digital twins will grow about 30% to 40% annually in the next seven years, reaching USD 125 billion to USD 150 billion by 2032.[6]

Integrating water resiliency and reuse into digital twin capabilities reveals even greater business benefits beyond productivity gains and operational improvements. Such newly efficient operations can lead to further reductions in resource (water and energy) consumption, waste and emissions, and on overall environmental footprint. Research suggests that digital twins, stacked with predictive modeling and data quality conditions, can help organizations reduce material costs by 18% to 37% through closed-loop production twins and generate over USD 420 million in new revenue per enterprise via closed-loop business models. This potential demonstrates that operational improvements, sustainability, and business resiliency are positively reinforced when facilitated by digital twin technology.

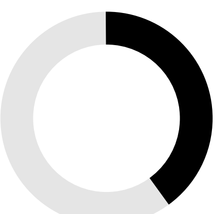
1.4 What role do digital twins play in accelerating a water resilient economy?

A resilient economy is one that can withstand, adapt to, and recover from economic, environmental, social, and geopolitical shocks while maintaining long-term prosperity and sustainability. Water-resilient economies, in particular, are economic systems that ensure long-term water security, minimize water-related risks (scarcity, flooding, contamination), and integrate sustainable water management into economic decision-making. Such systems not only address pressing issues—such as waste, water scarcity, pollution, and biodiversity loss—but also support the broader goal of decoupling economic growth from the consumption of finite resources.[7] The global state of energy and water presents a sizable economic opportunity, as the energy and manufacturing sector consumes an enormous amount of water. Two-thirds of the world's population experiences water scarcity for at least one month of the year. The global energy system consumes 370 billion cubic meters in 2021, equivalent to about 2.5 times the volume of Lake Tahoe.8 As energy demand increases, demand for fresh water to fuel data centers, refine critical minerals for clean energy technologies (batteries, wind generators), and support agriculture and food systems across the world also increases. Digital twins provide a meaningful inflection point for these industries to connect their systems, achieve more efficient operational outcomes, and collaborate on allocating resources in a more sustainable manner.

While a common, globally understood belief is that heavy industry and energy sectors must consume less water, there is an opportunity to reshape that belief to embrace water reuse and recycling, along with leveraging data to monitor water use more efficiently. The key market drivers pushing a more resilient economy to the forefront include:

- **Business continuity and growth:** Essential industries, such as the water, energy, and built environment sectors, currently experience the dual challenge to meet stronger water efficiency and environmental targets while keeping up with aging infrastructure that has not yet been retrofitted amid rapid technological change.[9]
- **Resource constraints:** Heightened exposure to physical risks (natural disasters and infrastructural damage) and evolving risks (regulatory, market, and technology changes) accelerates the urgency for businesses to not only sustainably secure natural resources, but also engage in material reuse, recycling, and closed-loop production.
- **Supply chain vulnerabilities:** Geopolitical instability, economic trade barriers, supply chain vulnerabilities, and rising material costs exacerbated by climate risks are exposing the fragility of traditional linear supply chains, which benefit from closer data-driven tracking and monitoring methodologies.

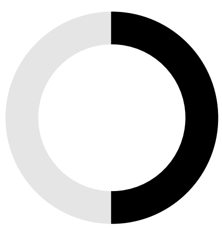
Water Scarcity:



By 2030, global water demand will exceed supply by 40%

(Source: World Economic Forum, 2023)

Population Impact:



By 2030, nearly half of the world's population could face severe water stress if current consumption and pollution trends continue.

(Source: Source: UN, 2016)

Water Security:

1.68B

By 2030, an estimated 1.6 billion people will lack safely managed drinking water, and one in four cities will face water insecurity, driven by climate change, pollution, and growing demand.

(Source: World Economic Forum, 2023)

1.5 Digital transformation can help address global water challenges

The global water crisis is a challenge that affects billions of people, ecosystems, supply chains, and organizations, and it is set to escalate in the coming decades. By the end of this year, it is projected that 50% of the world's population will live in areas designated as water-stressed.[10] Without solutions to conserve, recycle, and generate fresh water available to use, USD 70 trillion in global GDP (31%) could be vulnerable to water stress by 2050, up from USD 15 trillion in 2010.[11]

Addressing global water scarcity, poor quality, and access challenges requires integrating sustainable resource supply with a reliable data infrastructure to optimize resource flow, efficiency, and system resilience. Factors driving water scarcity are myriad, complex, and regional. Thus, addressing global water stress requires us to introduce context-specific, adaptive, and predictive technologies that can identify new water resources, improve the efficiency of water operations, and properly allocate the movement of water resources so that both ecosystems and economies are offered localized, just, and resilient outcomes.

The potential for digital twin adoption as part of overall digital transformation through the lens of the water security and resiliency is particularly significant. For sectors such as water utilities and water resource management, digital twins can be used as a response to sector-wide challenges, such as urbanization, the increase of data centers in response for AI, energy-related water demand for asset management, non-revenue water, regulatory compliance, and physical risks—to name but a few.[12] These challenges highlight the opportunity for new business models amid rapid technological innovation. Aging infrastructure, coupled with heightened environmental change, calls for a digital transformation. Digital twins—virtual, data-rich replicas of physical systems—offer a solution. They enable real-time monitoring, predictive analytics, and advanced simulations that empower managers to optimize resource use, minimize waste, and extend the lifecycle of physical assets. Consequently, digital twin technology has emerged as a strategic imperative, bridging the gap between closed-loop solutions and sustainable asset management while opening new opportunity pathways for businesses, ecosystems, and countries to be more resilient in the face of environmental change.

2.0 Landscape analysis: The current state of digital twin implementation

The core value proposition of digital twins lies in their ability to synchronize real-world sensor data with advanced simulation engines, creating living models that enable predictive optimization of operational parameters, such as energy and water consumption. This capability extends beyond operational efficiency into product lifecycle management, where digital twins facilitate material selection processes that reduce virgin resource consumption by 17% to 30% across industries.[13] The technology's spatial modeling capacities prove particularly valuable in resource reuse and management applications, enabling manufacturers to simulate closed-loop recycling systems and municipalities to track material inventories for urban planning initiatives.

Digital twin innovation is broadening the scope of sectors that can benefit from more efficient and closed-loop systems. Such sectors include the automotive, utilities, manufacturing, energy, water, heavy industry, and aviation. Notably, digital twins are increasingly being adopted by water utilities and water-related industries to optimize operations, reduce costs, and improve water management.

Digital twin adoption in the water sector have been significant. For example, in Gothenburg, Sweden, a digital twin of the sewage network reduced untreated water discharges into the environment by up to 50%, totaling 1.5 billion liters.[14] DEYAK Water Utility in Kosani, Greece, reported a 40% reduction in man hour times for pressure management and a 50% improvement in the speed and quality of repairs on leaks after implementing a digital twin.[15] Across various water utilities in Southeast Asia, digital twin users cite two resounding drivers for implementation: operational efficiency requirements and the demand for smarter water management to advance smart cities.[16] Such use cases demonstrate that digital twins can help water utilities anticipate problems, shift from preventive to predictive maintenance, reduce non-revenue water, improve energy efficiency, and enhance customer service.

2.1 Private sector innovations and case studies

Across the globe, companies and private entities are embracing digital twin technology as a transformative business opportunity that enhances operational efficiency and drives innovation. A comparative analysis of approaches to water resiliency in digital applications reveals a diverse range of strategies.

Company	Sector	Primary focus	Digital twin approach	Key metrics improved
Evides	Water	Optimized water operations and energy use	Implementation of digital twin for real-time insights into water operations and pump system optimization	33% of energy cost savings, equivalent to €300,000 annually and reduction of 942 tons of CO_2 emissions reduction per year (Kralingen site)
Deyak Water Utility	Water	Water treatment optimization	Implementation of a digital twin to monitor a water supply network, focusing on reducing non-revenue water and improving leak control and repairs	40% reduction in resource hour times for pressure management; 50% improvement in leak repair response
Thames Tideway (Joint venture of Costain, VINCI, and Bachy Soletanche)	Construction	Sewer system upgrade, sewage overflow prevention	Implemented digital twin technology to visualize the construction process, enabling better planning, coordination, and execution	95% reduction of annual wastewater discharge, reduction in pollution to enhance water quality for the next 120 years
National Highways	Transportation	Road network modernization and expansion	Integration of a digital twin to streamline infrastructure data, support efficient project delivery, improve traffic flow, reduce congestion, and enhance safety	£70M+ in projected savings through reduced rework and improved construction efficiency; streamlined project management
Siemens	Manufacturing	Optimized material use, waste reduction	Lifecycle modeling of construction projects, integrating BIM with material flow analysis	Reduced material waste (15%-20%), lower embodied carbon (8%-12%)
Microsoft	Cross-sector	Asset monitoring, lifecycle integration	Azure Digital Twins, connecting a range of source and integrating data, enabling a virtual digital asset across sectors	Reduced costs (15%-20%), improved sustainability metrics
Unilever	Consumer products	Packaging optimization, traceable recycling	Digital material passports, tracking material flows, optimizing packaging designs for recyclability	Increased recycling rates (10%-15%), reduced packaging waste (5-10%)
Singapore PUB	Water	Water loss reduction, network optimization	Real-time network simulation, identifying leaks, optimizing pressure, improving water quality	Reduced water loss (10%-15%), improved water quality (5%-10%)
Ford Motor Company	Auto manufacturing	AI-enhanced, adaptive manufacturing	AI implementation, adaptive manufacturing, and quality control, using reinforcement learning agents for 3D manufacturing quality improvement	Increase in manufacturing quality index (MQI) for complex parts using additive manufacturing in a shorter time

2.2 Public sector tailwinds driving the opportunity for digital twins

In the global public sector, digital twin technology is primarily driven by the opportunity to support policy decisions, trial new technologies before scaling them to state and national levels, and facilitate collaboration between government entities. Additionally, wide-scale implementation has been shown to reduce future resource and infrastructural costs, mitigate physical risk, and facilitate smarter and quicker decision-making. To date, the largest implementation activity has been observed in smart cities, urban planning initiatives, and built environment management. Such activity is driven by government incentives and sustainability mandates at both national and local levels, using technologies such as digital twins to monitor emissions reduction and water consumption.[17]

In the water utility sector, digital twins are revolutionizing how systems are managed, offering increased visibility into water distribution, treatment, and wastewater management.[18] For example, utilities are using digital twins to monitor critical parameters such as flow rates, pressure, and water quality, thereby identifying inefficiencies and reducing non-revenue water losses. By simulating various operational scenarios, water utilities can test innovative strategies for resource reuse and conservation, making their systems more resilient and sustainable. These capabilities facilitate data-driven decision-making, allowing operators to fine-tune processes and achieve optimized operational performance without resorting to costly physical trials.

Country-level developments: Governments worldwide are investing in digital twin technology to drive efficiency and stronger operational outcomes. For example, utilities in the Netherlands are implementing digital twins for flood management and water quality monitoring. Their “Room for the River” program uses digital twins to simulate the impact of shifting environmental conditions on water levels and design effective flood mitigation strategies. Several water utilities in Spain are using digital twins to optimize water distribution networks, reduce leakage, and improve water quality. The city of Valencia is implementing a digital twin to monitor and manage its water infrastructure in real time. More broadly, the European Union’s IDEATION project marks one of the first projects to digitize Europe’s inland water systems, rivers, lakes, reservoirs, wetlands, snow, and ice systems into one singular platform.[19] Similar initiatives are taking place in various parts of Latin America. In Brazil, for example, the National Water Agency (ANA) is promoting the use of digital twins for managing water resources in the São Francisco River basin. The digital twin is used to simulate the impact of climate change on water availability and optimize water allocation among different users.

Among the most notable examples of digital twin adoption on the global stage is Singapore, recognized for its achievements in creating the first complete replica of its country with precise detail down to the household level, completed in 2022.[20] The initiative, known as “Virtual Singapore,” was created by the Singapore Land Authority in collaboration with Bentley’s iTwin Capture technology to map its entire nation to more effectively manage its land and space resources while preparing for national emergencies and a rapidly growi ng island population. To date, Virtual Singapore and Singapore Land Authority’s use of iTwin Capture has helped increase data availability for its digital twin by 50%, saved one full year in capture and processing time compared to traditional mapping methods, and saved the country SDG 26 million.[21]

Why does this matter? Digital twins can help organizations make connections between resiliency, technology change, infrastructure efficiency, and economic growth. Such insights can highlight direct policy implications for countries worldwide, particularly in developing economies where state governments possess outsized roles to address growing populations while maintaining national development targets.

Recognizing the potential of digital technologies to address urban challenges, governments across the Asia-Pacific region are investing heavily in smart city initiatives, including the development of national-scale digital twins for urban planning, resource optimization, and disaster management. Many Southeast Asian governments have launched dedicated smart city initiatives, including Malaysia’s “Holistic Smart City Approach” and Thailand’s “Thailand 4.0” digitalization plan.

3.0 Strategic business benefits are engineered within digital twin technology

At their core, digital twins enable water resilience and reuse by allowing operators to leverage data insights that can produce more efficient resource management, minimize waste generation, and maintain hard assets for longer through their lifecycle. By creating dynamic, virtual replicas of physical assets, processes, or systems, they integrate real-time, site-specific information gathered via IoT sensors, historical records, and predictive simulation models to continuously update their virtual counterpart.

They are used in five primary areas based on the sales of software for implementation: predictive maintenance (39.9%), business optimization (25.3%), performance monitoring (17.8%), inventory management (11.9%), and product design and development (3.4%). The remaining applications represent 1.6% of the sales. Digital twins primarily function to make predictions or as a status indicator for the system being modeled.[22]

39.9%
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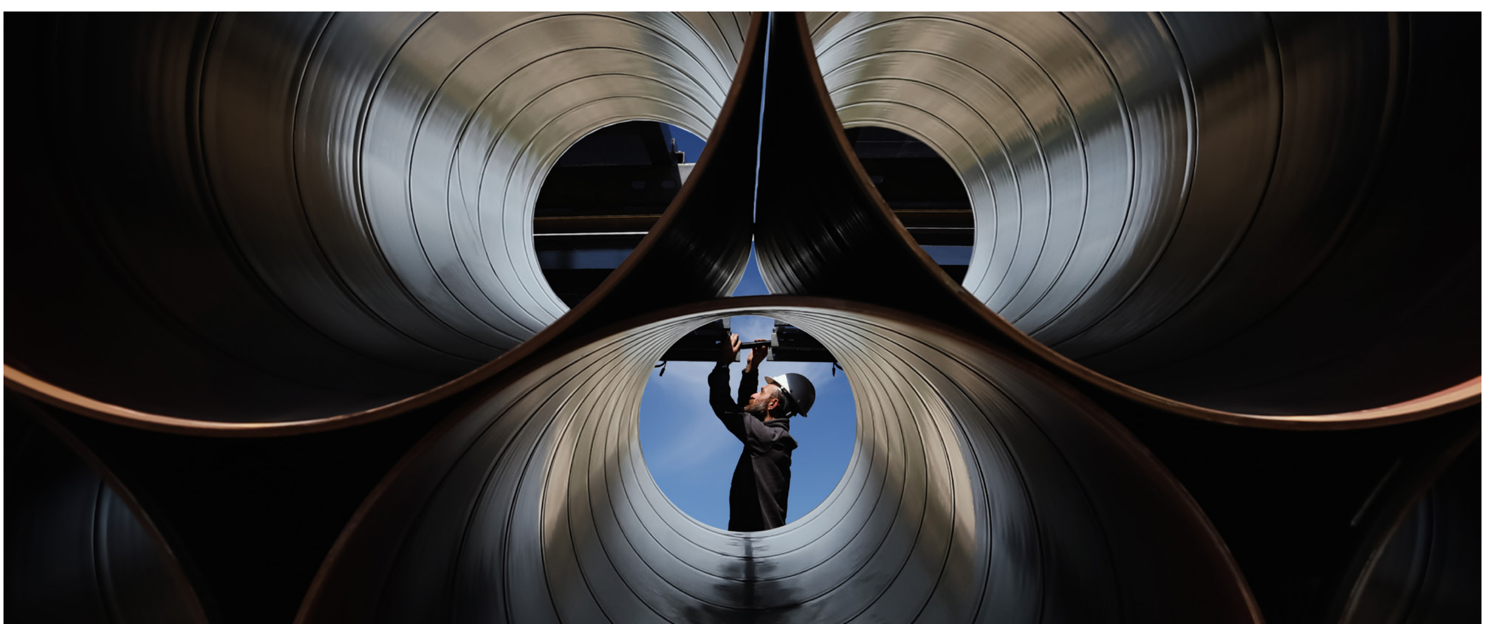
11.9%
inventory management

3.4%
product design and development

1.6%
remaining applications



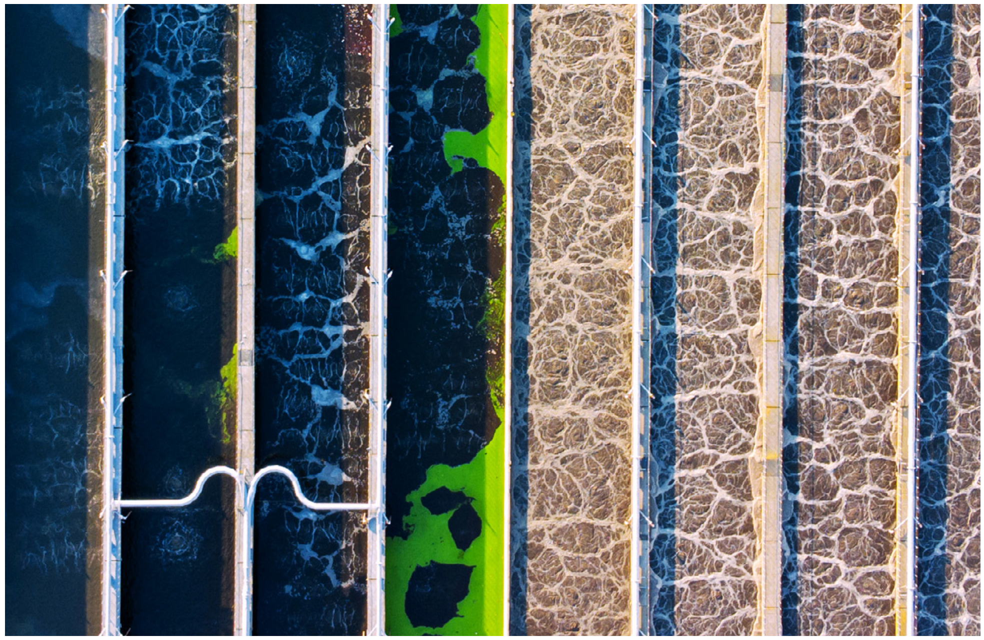
Broadly, there are two types of digital twins[23]:

Asset digital twins focus on high-value assets (e.g., boilers and pumps) to monitor health, predict maintenance, and optimize performance. They work by collecting sensor data specific to the asset and comparing its behavior to established performance curves, thus identifying anomalies and predicting failures.

Operational digital twins manage complex systems (e.g., water and wastewater) to optimize throughput and support tactical control room operations. They accomplish this by modeling the entire system, from input to output, allowing operators to simulate changes, test potential scenarios, and make efficiency improvements.

In the context of water utilities, for example, integration is achieved through several key steps:

1. **Data acquisition:** Real-time data is collected from sensors, IoT devices, and other sources monitoring the physical asset. This data can include temperature, pressure, vibration, location, and performance metrics. In water utilities, digital twins start with extensive sensor networks deployed throughout the water cycle—from water intake, treatment, and distribution to wastewater collection. Sensors capture key data (e.g., flow rates, pressure, water quality, energy usage) in real time and feed it into the digital twin via SCADA and IoT systems.
2. **Model creation:** The acquired data is fed into a sophisticated digital model, often a 3D model, that replicates the structure and behavior of the physical asset. For water utilities, the data collected is processed through advanced hydraulic and water quality models.
3. **Model simulation and analysis:** The digital twin model is then used to simulate various scenarios, predict future performance, and identify potential problems. Using AI and machine learning, the digital twin simulates scenarios such as peak demand, equipment failures, and flood events. These simulations allow engineers to run "what-if" tests—predicting, for example, how a change in pump operations might reduce energy use or water loss.
4. **Feedback and optimization**: Digital twins in water management are fundamentally dynamic. Virtual models are continuously updated based on real-time data inputs and boundary conditions set in place by the operator. This process creates a feedback loop where insights from the digital twin, such as early leak detection, pump breakage, or inefficient pressure zones, trigger proactive maintenance or operational adjustments—mitigating risks before they escalate.



Category	Value driver
Operational performance	• Predictive maintenance: Data-enabled maintenance strategy. • Remote watershed monitoring: Temperature, flow, pH, nitrates. • Simulations and visualization abilities: Augmented, virtual and digital twin realities.
Financial performace	• Reduced operational expenditure: Optimised energy use and reduced maintenance costs. • Increased captital efficiency: Reduced libaility of unplanned maintenance (e.g. water main breaks). • New value propositions: New digital payment methods, and flexible tariff structures.
Long-term resilience	• Analytics and insights: Better anticipate and adapt to climate and demographic changes. • Workforce development and empowerment: Improved cross-department collaboration and informational assistance systems to reduce safety risks and train the workforce in new roles. • Crisis response and recovery: Expedite crisis response and recovery by detecting contamination incidents faster and introducing self-repair options.
Customer service	• Customer engagement channels: Customer interaction models across web, mobile, connected home, and in-person. • Improved water meter data management: Leak detection, improved consumption accuracy and water use insights. • Digital water products and billing systems: Time-of-use tariffs and blockchain solutions.
Regulatory compliance	• Environmental sustainability: Leverage new efficiencies to reduce carbon emissions and reduce critical water losses. • Water quality compliance: Online monitoring, water quality models and scenario modeling. • Digital collaboration platforms: Collaborate with regulatory authorities, policymakers, and peers through digital platforms to more effectively meet complaince demands.

3.1 Data integration and interoperability

Research and insights with industry experts across the water sector suggest that while digital twins offer strategic business benefits, data fragmentation and interoperability concerns remain a meaningful challenge in achieving commercial scale and accuracy.[24] Many organizations that are "data-rich" upon digital twin implementation remain "information-poor," struggling to convert abundant data into actionable insights. In other cases, data quality is cited as a common reason for limited predictive power. For a water resource management company in Brazil, stakeholders cite that "compatibility issues between systems are common, especially due to the lack of interoperability in legacy platforms that were not designed to integrate with modern technologies. The lack of data standardization results in interpretation errors and inconsistencies." Several utilities across North American and Asia-Pacific regions note that data cleansing, calibration, and integration with existing infrastructure systems must be addressed before digital twin technology accurately reflects their physical systems and operational success can be realized.

What solutions exist for businesses to mitigate adoption risk?
Across the water utility sector, where systems can be vast and complex, issues like sensor drift, connectivity interruptions, and heterogeneous data formats may compound data quality concerns. Overcoming challenges related to data heterogeneity and interoperability requires adherence to established open data standards. The deployment of advanced middleware solutions and robust application programming interfaces (APIs) is equally essential, enabling legacy systems to interface effectively with modern cloud-based platforms. Recent developments created by Oracle, for example, leverage artificial intelligence to integrate legacy data sources. These technical solutions collectively help digital twin applications remain scalable, secure, and responsive to real-time operational dynamics.

3.2 Lifecycle management with digital twins

Insights from diverse stakeholders across the water industry reveal that the clearest value drivers that directly impact organizations' financial health are reduced energy and water consumption costs. More e fficient operations have the potential to reduce the rate of asset depreciation, extend the lifetime of business products and systems, and save money for both producers and consumers of digital twins.[25]

A key component of lifecycle management is "digital material passports"—detailed records of a product's materials, components, and environmental impact throughout its lifecycle. These passports, often leveraging blockchain technology for traceability, enable efficient recycling, reuse, and remanufacturing at the end of a product's life.[26] The Fraunhofer Institute, a leading research organization in Germany, is at the forefront of developing digital material passport standards and technologies. Their research focuses on integrating lifecycle assessment (LCA) tools with digital twins, enabling organizations to quantify the environmental benefits of different design and operational choices.

As closed loop system regulations like the EU's Digital Product Passport come into effect, lifecycle management capabilities enabled by digital twins will become essential for compliance and a competitive advantage.

Insights gathered from stakeholder interviews across North America, Southeast Asia, Europe, and Latin America reveal that water utility and water-related industries are primed to move toward "singular digital twins," designed to represent physical systems using both sustainability and operational metrics. This trend contrasts with historical uses of digital twins, where operators primarily implemented digital twins with boundary conditions solely addressing productivity, product quality, material use, inventory, and logistical costs. The byproduct of more efficient operations is that water facilities, treatment plants, and utilities also achieve lower waste and energy consumption, which can compound financial savings while meeting sustainability targets.

> "Digital twin data can help operators identify, track, and redirect their natural resources."
>
> -Dragan S.

Water Network Digital Twin Market

The Water Network Digital Twin Market reached $1.82 billion in 2024 and is projected to grow at a CAGR of 13.7%, reaching $5.61 billion by 2033

(Source: Growth Market Reports Water Network Digital Twin Market Research Report 2033)

4.0 What financial considerations are prompting the use of digital twins?

The implementation of digital twin technology has been shown to yield substantial financial returns. Empirical studies and real-world case analyses indicate that organizations adopting digital twin solutions can experience operational expense reductions of up to 20%, primarily through improved asset management, predictive maintenance, and process optimization.

Research highlights that digital twins significantly minimize unplanned downtime—a common and costly disruption for asset-intensive industries. By enabling real-time monitoring, scenario modeling, and early fault detection, digital twins help organizations avoid reactive maintenance costs and extend asset lifespans. These financial gains often offset the initial capital investment, making digital twins a compelling component of long-term digital transformation strategies.

Beyond cost savings, digital twins also unlock new revenue streams by optimizing resource utilization, enhancing service delivery, and enabling data-driven decision-making. As industries face increasing financial pressures from regulatory compliance, sustainability mandates, and market volatility, the economic case for digital twin adoption is becoming even stronger, positioning the technology as a strategic enabler of both efficiency and profitability.

How can businesses and operators secure financing for digital twins from their budgets?
According to insights from a director of a U.S.-based national laboratory and a municipal water resource manager in San Francisco, most entities, such as utilities and heavy industry operators, have historically not considered digital transformation technologies as viable investments: "It is expected that conservative industries like the water sector do not have a line item for innovation on their balance sheet, but [dedicating investments towards digitization] can yield substantial business value beyond financial returns. Digital twins should be seen in the same light as advanced metering infrastructure (AMI), which is already commercially adopted among utilities." Other experts state that instead of allocating external capital for environmental solutions through venture capital or direct co-investments, businesses can redirect this capital back into digitizing their own systems. A chief commercial officer and municipal water leader in Canada states that "reinvesting capital into your own operations [through digital twins] will likely provide you with more active control and ownership, as opposed to equity-based investments in external solutions [early-stage water startups] that can accelerate broader environmental goals, but may not be directly material to your business."

4.1 Demonstrating the ROI of digital twins

Industry research suggests that digital twin technologies can play a meaningful role in addressing operational efficiencies, which can collectively reduce enterprise-wide business costs by 19% while also growing overall revenue by 19%. Entities that are tracking ROI are observing significant returns, with 34% of peers generating returns anywhere from 21% to 30%.[27] For example, for a water services company based in Brazil, implementation of digital twins and hydraulic modeling infrastructure to help manage wastewater management along the Tiete River resulted in a 30% reduction in sewage overflows, reduced work hours from 1,200 hours to just 120, and improved water savings to 37,000 cubic meters per month. In total, the digital twin saved the city over USD 4.6 million by optimizing sectorization and improving resource allocation. In a coastal region of São Paulo already facing significant water supply challenges from tourist spikes and drought while accommodating a population of 15,000 residents, such results not only highlight direct cost savings, but also expands opportunities for utilities to defer major capital investments and optimize resource utilization to other assets amid both financial and environmental constraints within the countries they operate in.[28]

According to experts, there can also be costs from inaction when failing to adopt or incorporate digital twin technologies into business. In the broader economy, the financial stakes are at their highest over the last 15 years: rising costs of capital and increased investor pressure for returns amid regulatory mandates, economic volatility, and evolving consumer preferences have heightened the demand for quantitative scenario planning and materiality risk assessments.[29] As a result, digital twin features, which offer scenario-building capabilities coupled with predictive analytics, can a) quantify the probability of financial success while b) further securing investor capital.

Corporates without digital twin adoption risk:

7-14% market share and business value loss to competitors digitizing their systems by 2028[30]

1-2% increase in borrowing costs for green bonds or sustainability-linked loans that can further secure financing for corporate waste and reuse initiatives[31]

USD 18-42 MILLION in annual penalties from 2027 EU digital product passport mandates, which track the lifecycle footprint of different products[32]

4.2 Unlocking financing opportunities with digital twin implementation

Digital twin platforms do more than reduce costs—they create new financing opportunities by enhancing operational efficiency and risk management. Lenders and investors are increasingly prioritizing data-driven performance indicators when assessing creditworthiness, and utilities that can demonstrate measurable improvements—such as reduced operational costs, increased asset longevity, and optimized resource allocation—are better positioned to secure favorable financing terms. Investors and lenders are increasingly integrating sustainability metrics into their decision-making processes, and utilities that can demonstrate real-time performance improvements—such as reduced energy consumption, lower water loss, and minimized environmental impacts—are more likely to attract sustainable financing. For instance, a utility that employs a digital twin to optimize its water treatment operations and reduce non-revenue water can leverage this performance data to secure lower-cost capital for future infrastructure projects, effectively turning operational excellence into a competitive financial advantage.

Looking ahead, the trend of incorporating digital twin data into financing criteria is expected to grow, further incentivizing adoption from utilities. Experts in smart water systems state that "as financial institutions continue to refine their risk models and incorporate digital performance indicators, utilities with robust digital twin systems will likely become prime candidates for preferential financing." This evolution not only supports the broader goals of planetary stewardship and resource resiliency within the water sector, but also fosters a business ecosystem where smart, data-driven infrastructure management becomes a central to generating economic, natural resource and environmental benefits.

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