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Integrating Innovative Solutions in Water and Sanitation Utilities

Lessons from Innovation Pilots in Latin America and the Caribbean

Author:
Ilan Adler Brzezinski

Editors:
Alejandro Minatta
Hila Cohen-Mizrav
Marcello Basani

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Contents

Abbreviations

AI	Artificial Intelligence
CAJ	Companhia Águas de Joinville
DMA	District Metered Area
EAAB	Empresa de Acueducto y Alcantarillado de Bogotá
GIS	Geographic Information Systems
IDB	Inter-American Development Bank
IT	Information Technology
KPI	Key Performance Indicator
LAC	Latin America and the Caribbean
L/s	Liters per Second
MDB	Multilateral Development Bank
NRW	Non-revenue Water
R&D&I	Research, development, and innovation
ROI	Return on Investment
SADM	Servicios de Agua y Drenaje de Monterrey
SAR	Synthetic Aperture Radar
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goal
SEDAPAL	Servicio de Agua Potable y Alcantarillado de Lima
SNIS	Sistema Nacional de Informações sobre Saneamento
SWIT	Smart Water Infrastructure
TC	Technical Cooperation
WSA	The Inter-American Development Bank's (IDB) Water and Sanitation Division
WSS	Water Supply and Sanitation

List of Figures and Tables

Executive Summary

Innovation in the water supply and sanitation (WSS) sector can contribute to achieving the goal of availability and sustainable management of water and sanitation for all. However, innovation initiatives in the WSS sector in the Latin America and the Caribbean (LAC) region face significant challenges. WSS utilities and service providers, in particular, have shown marginal levels of innovation, low integration of innovation into their business practices, and low levels of new technology adoption. This technical note presents findings from an analysis of innovation pilots in WSS utilities and provides practical and actionable knowledge that may contribute to facilitating the adoption and integration of innovative solutions for WSS in LAC. Four pilots were selected for analysis in order to include a variety of experiences in terms of the type of solution selected, the country, and the size of the utilities:

- Remote leak detection through satellite imagery: ***SADM,*** Monterrey, México
- Optimization of operational efficiency through smart data: ***CAJ***, Joinville, Brasil
- Cloud-based event management through AI: ***SEDAPAL***, Lima, Perú
- Real-time wastewater intelligence on industrial discharges: ***EAAB***, Bogotá, Colombia

Each of the pilots was analyzed against an innovation framework, the stated goals of each pilot, and the likelihood of scaling beyond a piloting stage. Several key aspects played a role in successful implementation of the pilots as well as the utilities' adoption of the technology during the pilot implementation stage:

- **Desirability**: It was important to have buy-in at several levels within the utility: decision-makers and upper management, the implementing unit, and other stakeholders in the utility who were needed to deploy and use the new technology. This buy-in can be achieved by including all stakeholders from the very beginning when defining the challenge, choosing the solution, and implementing the pilot. Tying pilot implementation to the staff's work plans and KPIs can help improve their involvement.
- **Feasibility**: To make the most of a new technology, the utilities needed to have technical capacity at a hardware, software, and human level. Without necessary telemetry and data management in place, solutions that depend on adequate and timely data may not be fully utilized or may be delayed in yielding results. Furthermore, it was essential to have properly trained staff to use and capitalize on the innovative solution (e.g., having operational managers act on data or leak repair units to promptly address newfound leaks).

- **Viability:** A demonstration of how solutions contribute to the utilities' bottom line was key to making a case for using the solution beyond the pilot stage. In one case, it was estimated that fixing the leaks found during the pilot would provide a return on investment (ROI) within a month. In another, the solution provided the utility with the tools to enforce environmental compliance. Economic return is key to a utility's desire to adopt new solutions.

While pilots are important for testing out new solutions and reducing risks, taking an innovation to scale is important for improving WSS service and access. Having successful pilots, with clearly stated key outcomes, helps build a case for scaling. Integrating piloting and innovation into a utility's development and work plans can also contribute to taking new solutions beyond the pilot stage into implementation at scale as part of the utility's operations. Finally, having in place the proper governance framework along with an enabling environment in which utilities can implement new solutions is essential for facilitating innovation at scale.

1 Introduction

Innovation in the water supply and sanitation (WSS) sector can contribute to achieving the sector's Sustainable Development Goals (*SDG 6. Ensure availability and sustainable management of water and sanitation for all*). In Latin America and the Caribbean (LAC), however, such innovation faces several challenges in terms of: (i) governance efforts; (ii) research, development, and innovation (R&D&I); and (iii) the marginal level of innovation, lack of integration of innovation into management processes, low technology adoption, and lack of investment sources for innovation among WSS utilities (Minatta & Basani, 2020).

To improve the quality of life for people in LAC, and to promote innovation that will foster solutions for universal, affordable, quality, efficient, and sustainable WSS services in the sector, the Inter-American Development Bank's (IDB) Water and Sanitation Division (WSA) developed a roadmap that can serve as a guide. It includes "cardinal points" that provide a general direction, and action items to address each of the three challenges mentioned above. In the context of promoting innovation management among utilities and service providers, one of the actions pertains to developing knowledge products to facilitate promotion of innovation in the sector (Minatta & Basani, 2020).

The IDB WSA's roadmap for innovation (Minatta & Basani, 2020) found there are limited innovation initiatives in the WSS sector in LAC. Some of the findings include:

- There is a limited number of reports available on innovation in the region's WSS sector.
- There is a marginal level of innovation among WSS service providers.
- The culture of innovation among service providers in LAC is lower than that of international benchmarks.
- Most operators do not integrate innovation into their business processes.
- WSS service providers in LAC adopt technology at a level that represents less than half of their international counterparts.
- WSS utilities in LAC lack investment sources for innovation, with only 1 out of 5 investing a portion of their income on innovation.

Given these findings and the importance of innovation in boosting economic and social development and promoting better quality of life (OECD, 2012), fostering innovation and innovation management is crucial for WSS in LAC.

This report contributes to the growing literature on innovation in the LAC WSS sector by increasing the availability of practical and actionable knowledge that can contribute to facilitating adoption and integration of innovative solutions that result in safely managed water and sanitation services for all. It does so by drawing on evidence from implementation of innovation pilots under the IDB-Israel Collaboration: Capacity Building in Water Technologies technical cooperation (TC) carried out 2019–2022.

1.1 Objective and methodology

This report seeks to provide evidence-based lessons for the sector that may contribute to facilitating the development and integration of innovative solutions. To do so, it posits two key research questions: i what lessons can be learned from implementing innovation pilots that can contribute to their successful execution? and ii what insights can be drawn from these pilots that can contribute to the scaling of innovation in WSS utilities in LAC? To that end, we developed an evaluation framework to analyze four case studies in the region and conducted a desk review of terms of reference and reports. A series of stakeholder interviews contributed to much of the information provided in this report.

The report is structured into four sections: **Section 1** offers readers a brief background on innovation in the WSS sector in LAC and provides the theoretical framework through which the innovation pilots were evaluated. **Section 2** presents the objectives of the TC, the four case studies chosen for evaluation, and the main takeaways from the case studies (research question i). **Section 3** delves into the insights obtained from the case studies that may contribute to scaling innovation in the WSS sector in LAC (research question ii). Finally, **Section 4** presents the main conclusions.

1.2 Background

This section presents a brief conceptual introduction to innovation in the form of a quick overview of the innovation challenges faced by the WSS sector in LAC, and the evaluation framework used for the innovation pilot case studies.

1.2.1 Innovation in the WSS Sector in LAC

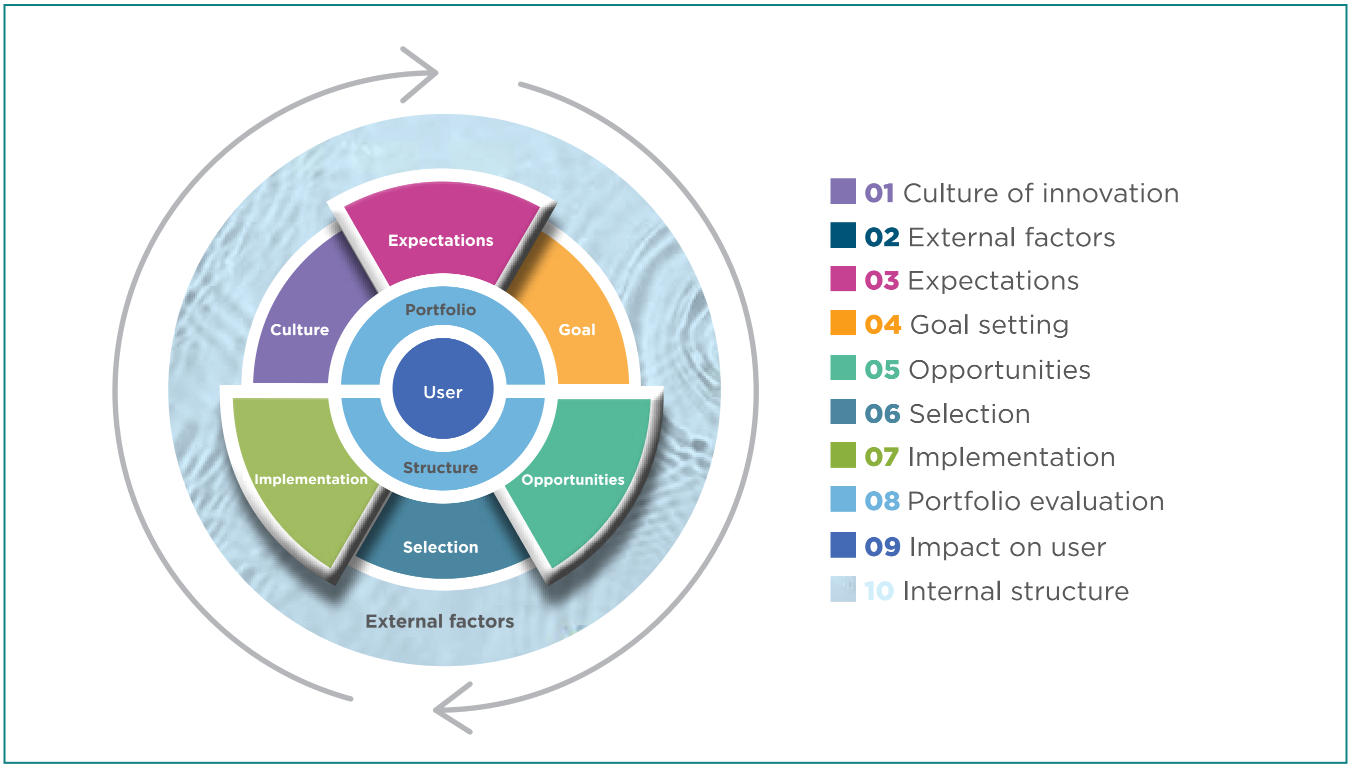
The definition of innovation has varied over time. Existing literature offers multiple accepted definitions, which are adapted to the context, priorities, internal characteristics, and degree of risk tolerance of the entity engaging in innovation.

Innovation can be thought of as: i a new idea, method, or device; the introduction of something new (Merriam-Webster, n.d.); ii the ability to generate and execute new ideas—[be they] incremental, evolutionary, or revolutionary—starting with creativity (IDEO U, n.d. b); or iii a new or improved product or process (or combination of both) that differs significantly from previous products and processes, and is available to potential users (in the case of products) or is in use by an organization (in the case of processes) (OECD & Eurostat, 2018). The concept of innovation is associated with anything of a novel nature, previously absent among WSS service providers in its territory and/or internationally. In addition, it is fundamentally associated with the creation of a proposal and the provision of a benefit or satisfaction of the client or end users (Minatta & Basani, 2022).

The main challenges innovation faces in the WSS sector in LAC can be divided into three categories: i governance efforts; ii research, development, and innovation (R&D&I); and iii the marginal level of innovation, lack of integration of innovation into their management processes, low technology adoption, and lack of investment sources for innovation among WSS utilities (Minatta & Basani, 2020).

To help reduce the innovation gap in the aforementioned WSS utilities, innovation management requires addressing and integrating a series of fundamental aspects that can generate additional value. These aspects are described within a conceptual innovation management model proposed by Minatta, Basani & Shaki (2022) and include: a) internal factors (innovation culture, expectations for innovation, goals and opportunities, selection, implementation, portfolio evaluation, user and structure of innovation), and b) external factors (sectoral governance including policy makers and regulators; innovation ecosystem (R&D&I), society, and the environment).

Figure 1: Conceptual innovation management model in WSS for LAC



Source: (Minatta, Basani & Shaki, 2022).

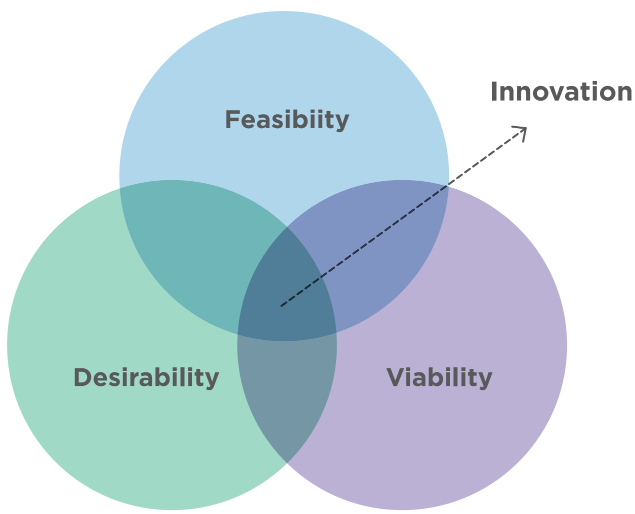
Based on the characteristics of each WSS service provider, the prevailing circumstances at the time of decision-making, and their general strategic perspective regarding the future, these fundamental factors can be activated and articulated in a systematic and systemic way through a practical circuit, involving 10 distinct steps:

- Step 1: General management begins the circuit by promoting a culture of innovation (Minatta & Basani, 2021)
- Step 2: External factors (society, sectoral governance, the innovation ecosystem (R&D&I) and the environment) are considered (Minatta, Basani & Shaki, 2022).
- Step 3: Clear expectations for innovation are set
- Step 4: Specific goals are set
- Step 5: Innovation opportunities are generated
- Step 6: Specific innovation opportunities are selected
- Step 7: Innovation projects like prototypes and pilots are implemented
- Step 8: The portfolio of solutions is evaluated
- Step 9: The impact of the portfolio of solutions on service users is evaluated
- Step 10: The internal structure that drives innovation in the WSS service provider is considered (Minatta, Basani & Shaki, 2022).

1.2.2 Evaluation framework for innovation pilots

For the purpose of analyzing and evaluating the pilots corresponding to step 7 of the innovation management model (see Section 1.2.1), we developed an analytical framework for innovation in WSS utilities that draws on design thinking and experience in working with public WSS utilities. A design thinking framework helps understand whether and where innovation may be occurring. Innovation means that a product or service is "desirable from a human point of view [and] is technologically feasible and economically viable" (IDEO U, n.d. a).

Figure 2: Elements of innovation

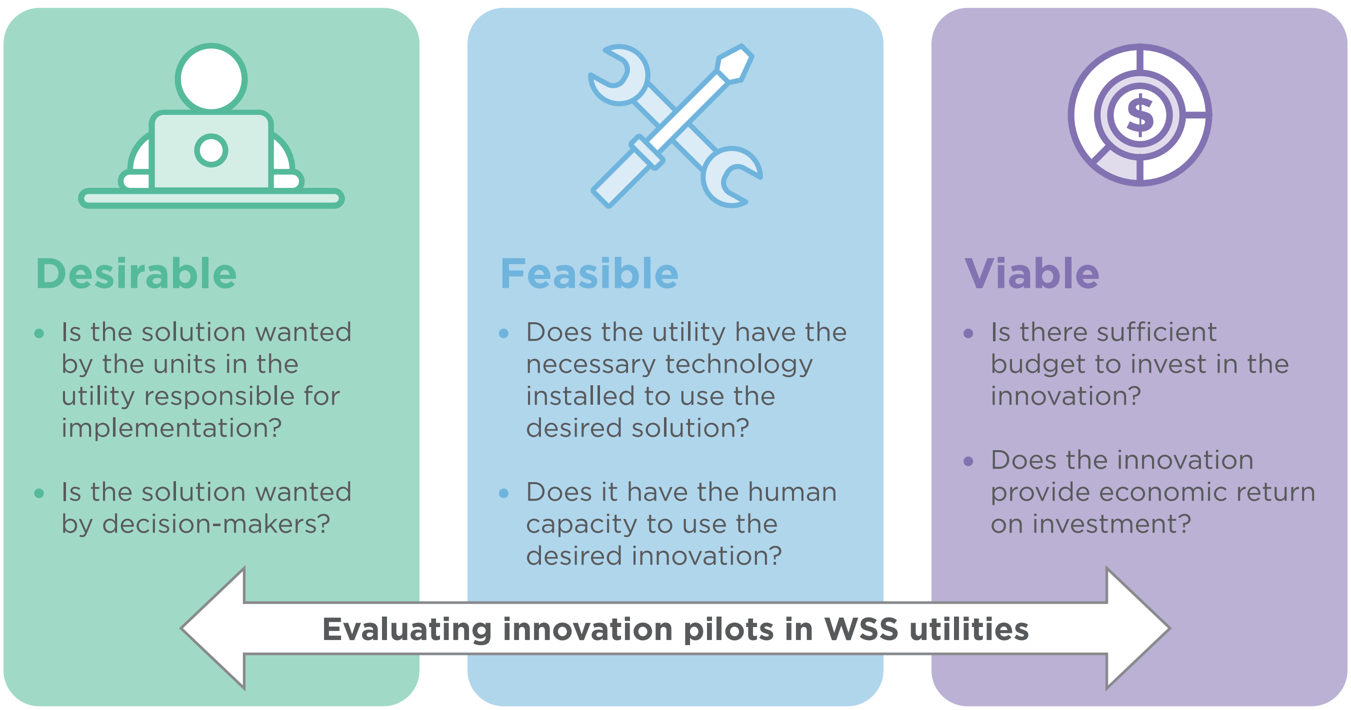


Source: (IDEO U, n.d. a)

In terms of WSS utilities, decision-making and implementation of innovative technologies or processes occur at different levels. From a **desirability** standpoint, end users, which in this context are the units, teams or people using a specific technological solution (usually an operational unit that will implement it) as well as decision-makers (upper or general management, or the board) must want the new solution. A **feasible** solution requires human capacity to implement it, in addition to the technological requisites. Finally, **viability** is determined by the utility's ability to invest in a solution and derive economic returns from it. It is important to note that while return on investment (ROI) is an important element of economic returns as it relates to financial sustainability, public WSS utilities in LAC may also derive benefit from innovations in the form of environmental sustainability, improved social indicators (lower mortality rates, better health), and improved fulfilment of regulatory responsibilities (resource management, pollution amelioration, information gathering).

Based on the considerations above, the following framework was developed to capture the processes and lessons of innovation in the implementation of the pilot case studies in this TC:

Figure 3. Analytical framework for learning from innovation



Source: Author.

In addition to evaluating the various aspects of innovation, this report looked at the success of each of the pilots along two dimensions: i the degree to which the pilot achieved its stated outcomes; and ii the potential future scalability of the pilot.

DEFINING SUCCESS: This paper attempts to capture two success factors through the innovation pilot process:

1. The degree to which each of the pilots achieved the outcomes it set out to achieve – reduce non-revenue water (NRW), increase treatment capacity, implement monitoring systems, etc.

2. The scalability of the pilot in the future, which can be appreciated by whether it is desired by the WSS utility, economically viable, and technically feasible.

Finally, WSS utilities do not operate in a vacuum. Their ability to innovate is related to their internal processes (innovation culture, expectations, and goals) and tied to their context (society, sector governance, innovation ecosystem, and environment). Internal processes can determine the ease with which utilities procure and adopt new technologies, while their ecosystem determines whether there is political will or an existing normative framework for a utility to innovate.

2

Integrating innovative solutions in water and sanitation utilities in LAC

This section attempts to answer the first research question: what lessons can be learned from the implementation of innovation pilots that can contribute to their successful execution? It starts by presenting the background of the innovation pilots and goes on to analyze in further depth the four specific pilots, including their challenges, innovative solutions, and results, as well as lessons related to innovation.

2.1 Background on the innovation pilots

In 2018, the IDB and the Government of Israel initiated technical collaboration to share and disseminate Israeli knowledge, technologies, and management systems among IDB member countries and stakeholders responsible for addressing water and sanitation challenges. The main objective of Technical Cooperation (TC) RG-T3298 (IDB-Israel Collaboration: Capacity Building in Water Technologies) is to assist IDB borrowing member countries to improve their knowledge and strengthen their capacity for the development and adoption of innovative technologies and management systems in the water and wastewater treatment/reuse sectors. The operation comprises three main components: (a) knowledge sharing, (b) training, and (c) pilot project design.

The objective of the TC was *to assist IDB clients in improving knowledge and strengthening capacities through innovative water technologies and management systems to address water security challenges.* The pilots focused on smart water infrastructure (SWIT), reuse, desalination, and sector policy reform. Utilities were selected through a demand-driven, iterative process. Through IDB's *Ideas en Acción,* an open call for challenges was made, inviting utilities to present current difficulties they faced, which could be addressed through the use of new technology. The utility's challenges were refined in collaboration with the IDB and the Israeli Innovation Authority, which placed an open call for private service providers with solutions in the areas specified above. Once experts in the Innovation Authority created a shortlist of companies with proven experience in the sector, it was presented to the utilities so they could select the most appropriate solution to their challenge. This process culminated in a variety of pilots, presented in Table 1 below:

Table 1: Innovation pilots supported through the TC for WSS utilities in LAC

Project name	Country	Partner	Main objective/description
Detection of water leaks in the drinking water distribution network of the city of Cañada de Gómez	Argentina	Santa Fe	This pilot implemented remote detection of losses based on satellite inspection in the city, with the aim of primary detection of non-visible leaks to reduce NRW.
Optimization of water supply system operation Águas de Joinville	Brazil	Joinville	The pilot implemented a comprehensive optimization solution for Companhia Águas de Joinville (CAJ) system that included data collection and analysis, allowing the company to process real-time data and identify recurring patterns of water loss, and changes in water pressure and water quality. The pilot established a data management display and communicated data to support the decision-making process.
Detection of drinking water leaks in the distribution network in Autonomous Water and Sanitation Service of Parauapebas (SAAEP)	Brazil	Parauapebas	The pilot implemented leak detection through use of a satellite inspection system in a portion of the drinking water network operated by the company SAAEP in Parauapebas, Brazil.

Project name	Country	Partner	Main objective/description
Evaluation of industrial effluents in a pilot area of the sewage system of Bogotá	Colombia	EAAB	This pilot evaluated the applicability of an intelligent predictive system that includes continuous monitoring of wastewater quality and intelligent data analysis to identify non-compliant sewerage network discharges in a pilot area of Bogotá. The goal was to assist utility managers and network operators in taking corrective actions and, thus, improve the efficiency and sustainability of operations over time.
SWIT for Port Mourant and Sheet Anchor	Guyana	GWI	The pilot implemented a technology to improve analysis, identification, and management of anomalies in the operation of selected water distribution systems by introducing a proprietary cloud-based event management product during a defined period.
Detection of water leaks in the distribution network of the Monterrey Water and Drainage Service (SADM), Nuevo León	Mexico	Monterrey	The pilot implemented a remote leak detection system based on satellite inspection of a portion of the drinking water distribution network operated by SADM in Monterrey, Nuevo León, Mexico.
Water event management service for SEDAPAL	Peru	SEDAPAL	The pilot project implemented a cloud-based event management product in SEDAPAL for analysis, identification, and management of anomalies in operation of the water distribution system aimed at improving its efficiency.
Detection of water leaks in drinking water distribution networks in towns in inland Uruguay operated by OSE.	Uruguay	OSE	This pilot implemented a remote leak detection study based on satellite inspection of drinking water distribution services, in towns in inland Uruguay, operated by the company OSE to support leak detection and repair work in the field.

The demand-driven process described ensured attention to the utilities' needs by encouraging them to think about what they required, and commit financial and human resources to have ownership of the project.

2.2 Case Studies - Challenges, innovative solutions, results, and evaluation of pilots

Of the pilot projects described in Table 1 above, four were selected for a deeper dive based on the availability of information concerning innovation. Each case presents its own challenges, innovative solutions, results, and an evaluation following the framework proposed in the Section 1.2.2.

2.2.1 Remote leak detection through satellite imagery: *SADM*, Monterrey, México

Servicios de Agua y Drenaje de Monterrey I.P.D. (SADM) is a public, decentralized water and sanitation utility providing services across the state of Nuevo León, Mexico.

a. Challenge. SADM is responsible for providing water supply services in one of the driest basins in Mexico. In 2021 and 2022, it faced severe drought. While the utility has historical data and methodologies for determining NRW, measurement errors, and clandestine connections, it still experienced significant levels of physical loss in its water supply network. Leak detection is usually carried out manually or identified through user reports. While SADM has a good track record for repairing leaks, the pressing need to reduce losses and manage water more efficiently prompted the search for a solution that would allow SADM to reduce leak detection time.

b. Innovative solution. To address the challenge of faster leak detection, SADM chose to pilot satellite leak detection in an area containing 2,500 km of pipes. The solution partner was Asterra, which uses satellite imagery taken with a synthetic aperture radar (SAR) by means of microwave emission and its backscattering to detect moisture in the ground. Combined with its proprietary algorithm, which analyzes the images together with other data provided by the utility, Asterra helped reduce the search area by over 90% with the added benefit of being non-invasive, as compared to other methods.

c. Results. Asterra detected 190 points of interest in the pilot area, 113 of which were confirmed by SADM through use of acoustic equipment. These 190 points were found in only 6% of the 2,500 km of network, significantly reducing the search area and the time taken to detect and repair leaks. It is estimated that performance increased 59% per crew directly involved in leak detection, and 28% in the leak detection department overall. The total volume recovered by repairing these leaks averaged 4,750 m^3/day (55 L/s).

d. Evaluation of the innovation pilot.

Desirability. In the case of SADM, the decision-maker and end user of the tool were the same. This allowed the operational team to be closely involved in choosing the desired technologies to solve the challenge at hand. However, involvement of other stakeholders in the utility (leak repair, operational, and IT staff, for example) was key to ensuring successful implementation.

Feasibility. In Monterrey, the technical preconditions for using Asterra's satellite leak detection system were already in place. SADM has a model of its networks and zones with low pressure and insufficient water and was able to provide Asterra with GIS. This imagery was the basis for detecting 190 points of interest for finding leaks. Asterra's technology allowed narrowing down the search area to 10% of the total piloted network, and SADM was able to capitalize by having the necessary auditory methods to confirm the exact points of leakage. Because SADM had a pre-existing high capacity for detecting leaks manually, it was able to build on its expertise when applying Asterra's technological solution. This readily resulted in increased and improved efficiency in finding and repairing leaks. Regarding human capacity, implementation of the pilot was straightforward because SADM is well-organized, well-managed, and has significant planning capabilities. Knowledge transfer was identified as a key need in the pilot to strengthen SADM's capacity to use this new technology, especially to ensure that the data analysis capabilities of the software implemented were transferred to the utility.

Viability. The utility calculated that the savings resulting from investing in satellite technology for leak detection would result in a return on investment (ROI) within one month, based on the 55 lps reduction in leaks. These savings also contribute to the environmental sustainability of the utility's operation.

2.2.2 Optimization of operational efficiency through smart data: *CAJ*, Joinville, Brazil

Companhia Águas de Joinville (CAJ), Brazil, supplies potable water to 228,342 customers (a population of approximately 600,000 people) treating nearly 2,100 lps in two water treatment plants.

a. Challenge. Although the utility has been investing in reducing physical water losses to help preserve system sources, it has not yet achieved its goal of physical losses no greater than 500 l/connection/day. While CAJ is a very well-structured company, its in-house, manual leak detection methodology has not allowed it to achieve its physical loss reduction goals.

b. Innovative solution. To address the challenge of quicker and more proactive leak detection, CAJ chose to implement smart data analysis in four district metered areas (DMAs). Its solution partner was IOSight, which uses the utility's telemetry and metering data with its algorithms and dashboards to produce real-time (1-hour delay) dashboards and reports. Data analysis provides information on water balances, maximum and minimum flows, network events (leakages), water quality, and equipment (pump, valve, and reservoir).

c. Results. Using the data provided by the utility, IOSight created dashboards with indicators for each DMA. CAJ improved its access to information, going from annual reports to monthly information on DMAs and reservoirs in the pilot area. Smart data analysis helped predict possible leakages, which needed confirmation by SCADA and field teams. An analysis of nightly flows revealed a reduction in pressure during five hours per night, resulting in a significant reduction in leakage (about 15%.) Finally, the pilot showed the potential of proactive leak management, integrating information from the network, and having a dashboard that provides network event alerts.

d. Evaluation of the innovation pilot.

Desirability. Although initial demand for the solution came from the operational team, all stakeholders in the company were involved in preliminary discussions leading up to the design and selection of the pilot. The operational team wanted a type of online, real-time, smart data solution to integrate GIS, commercial, and leakage data, to allow it to analyze and improve operational efficiency. The innovation department, hydraulics and control team, control center manager, data engineer, and lab manager all participated in implementation of the pilot, which helped solve challenges (like data integration) along the way and achieve the desired results.

Feasibility. IOSight's smart data system was piloted in four DMAs that already had a sufficient level of district- and micro-metering. An additional 26 were validated for further analysis, and the remaining DMAs in the network would need increased micro-metering to provide sufficient outflow data to the system. There was some effort needed to have data availability, quality, formatting, and compatibility with the solution provider's software. On the human capacity side, during implementation, the need arose to further involve IT teams to find solutions to correctly send the data to the solution provider and ensure proper management of data inhouse.

Viability. At the time of this writing, the benefits of integrating the different data sources and having proactive leak management are being evaluated, and an economic proposal is being drafted for upper management.

2.2.3 Cloud-based event management through AI: *SEDAPAL*, Lima, Peru

Servicio de Agua Potable y Alcantarillado de Lima (SEDAPAL) is a state-owned water and sanitation utility that serves most of the Metropolitan Area of Lima, which has a population of around 10 million people in an area of 279,860 hectares.

a. Challenge. SEDAPAL aims to achieve 100% and 24-hour coverage of drinking water and sewerage service for the urban area of Lima and Callao and had initiated projects that had expanded coverage over the last decade. Given the area's low precipitation and a fast-growing population in the area, the demand for water is expected to significantly increase in the coming decades. Lima faces a water deficit, which makes physical loss management even more important, along with the challenge of promptly detecting leaks and anomalies in the system.

b. Innovative solution. To seek more efficient operation and improve its physical loss management, SEDAPAL chose to pilot a software that helps utilities monitor the network and detect network failures in 67 sectors (40%) of its network. The solution partner was Takadu, which uses cloud-based software and AI to detect events that are related to faulty assets, telemetry failures, and leakage events within the geographical boundaries of the DMAs. Its software also allows management of consumption and usage patterns, DMA breaches, and pressure issues by using AI algorithms to learn how the drinking water system behaves and to manage multiple events in the distribution network and commercial system.

c. Results. By using Takadu, early detection, analysis and identification of the affected area reduced the amount of time and resources needed to deal with leaks. Takadu technology as an event management center for SEDAPAL allowed the detection of more than 7,000 events, including water leakage, increased flow in the sectors, telemetry failure, broken or faulty meters, and increased and decreased pressure. The system also allowed the minimum night flow indicator to be tracked online as well as compared the current and historical status of hydraulic sectors and their evolution. Finally, SEDAPAL received an accurate estimate of its total water losses in the network, allowing it to properly estimate its operational and physical loss reduction needs.

d. Evaluation of the innovation pilot.

Desirability. The innovation department, which was the decision-maker in this case, was 100% committed to applying the new AI event management system. However, it was only at the later stages of implementation that users of the tool became more involved, creating a lag in pilot advancement. Although the tool was detecting water leakage events, the innovation team had no direct line to the field repair teams. This then prompted greater involvement from operational teams and managers, leading to direct communication with field teams in charge of repairs. As the pilot advanced, one of the operational managers saw the usefulness of the innovation in proactively reducing leaks and became very involved with the implementation.

Feasibility. SEDAPAL was able to test Takadu's AI event management system in 40% of its network where it had enough hardware to feed data into the solution provider's software. It took some time to create knowledge within the utility on how to use the tool and the information required for it to operate. In terms of capacity, while the utility had the know-how to repair leaks, the pilot did not have enough operational teams dedicated to it in the beginning. This was addressed during implementation, and as more capacity was dedicated to the pilot, implementation improved. Several teams were involved, each with specific functions: to understand the software, to collect and harmonize data, and to confirm and repair leaks.

Viability. In the case of SEDAPAL, the innovation pilot gave the utility the opportunity to test the technology, demonstrate how it is used, and evaluate its savings value. This evaluation is ongoing. However, Takadu estimated that early detection of leakage events allowed SEDAPAL to save over USD $800,000, considering it would have taken over a year to identify these leaks without the use of AI.

2.2.4 Real-time wastewater intelligence on industrial discharges: *EAAB*, Bogotá, Colombia

Empresa de Acueducto y Alcantarillado de Bogotá (EAAB), provides WSS services to the city of Bogotá. Its sewerage network receives wastewater discharges from 158,000 non-residential users, which EAAB is responsible for monitoring. These discharges often contain components that cause damage to the sewer system.

a. Challenge. Pollution control regulations in Colombia require compliance and reporting by utilities on key water quality parameters. As part of this, EAAB needs to monitor industrial effluents and their impact on the deterioration of the wastewater collection and treatment infrastructure as well as the incremental costs of operating and maintaining said infrastructure. Industries are required to present annual self-evaluations, and EAAB conducts technical and monitoring site visits, but these efforts are not enough to properly monitor industrial discharges. In addition, COVID-19 sanitary measures made on-site visits increasingly difficult.

b. Innovative solution. To address the challenge of continuous monitoring of effluent discharge, EAAB chose to evaluate the applicability of Kando, a statistical analysis solution with an intelligent predictive system that includes continuous monitoring of wastewater quality and intelligent data analysis for the identification of non-compliant sewerage network discharges in a pilot area. Use of this smart technology would help improve discharge control, allow for continuous monitoring with machine learning that could also provide event predictions, and provide utility managers and network operators with greater ability to take corrective actions that improve the efficiency and sustainability of operations over time.

c. Results. At the time of this writing, EAAB was in the process of finalizing the pilot with Kando. Some of the project achievements included a pollution index provided by Kando, comparing the eight sub-areas in the pilot, and prioritizing corrective actions that would have the most impact. In two sub-areas, five possible sources of contamination were found and confirmed. The utility also has information to make the case for the polluter to take corrective action thanks to continuous reporting of the pollution index, samples taken at the time the polluting event was identified, and lab results that confirm users did not comply with regulations. The utility also gained the ability to measure pollution and events not previously measured, and demonstrated how it is possible to achieve more control over industrial discharge using certain types of technology.

d. Evaluation of the innovation pilot.

Desirability. Like in the case of SADM, the decision-maker and end user of the tool in EAAB were the same, which allowed the sanitation department to be directly involved in selecting the desired solution for the innovation pilot. Again, involvement of other stakeholders in the utilities (operational, IT, and lab staff, for example) was key to ensuring successful implementation of the technology and making use of the information it provided.

Feasibility. This case proved quite unique, given that Kando's service model involves providing the entire service by installing hardware and software for real-time wastewater intelligence. The few adjustments that were needed because the GIS data did not match the actual topography of the system were easily made. On EAAB's side, dedicated operational teams were deployed to the implementation area, and the lab teams were available to sample and characterize pollution events as needed.

Viability. At the time of this evaluation, the pilot was being finalized and no information about savings or ROI is yet available.

Box 1. Lessons for implementing digital technologies

While the focus of this technical note is on innovation, an important mention should be made of key lessons in digital technology implementation.

Digital technologies in the WSS sector have multiple applications ranging from observing watersheds to enabling informed decision-making, tracking project impact, providing early warning for flooding, and monitoring water quality, quantity, land use and restoration. Globally, a growing number of water utilities use remote sensing, smart sensors, modeling, and event detection software to identify water leakages, pressure related problems, and monitor the real time status of their systems.[a]

Even though water utilities around the world are collecting a lot of data, most are not leveraging it effectively for digital transformation and have yet to meet the full potential of this data usage.[b] While this is true globally, in LAC, the potential of collecting and using data is far from being effectively used to improve water services in the region.

All the pilots presented in this note include elements of digitalization, from telemetry to data management to AI and real-time intelligence. Additionally, during the implementation period of this Technical Cooperation, global travel restrictions due to COVID-19 prompted the IDB and the client utilities to focus on implementation of digital technologies. Usage of digital technologies allowed teams from both the water utility and the technology companies to implement these new solutions without the need to be onsite.

a Sarni (2021).

b Stillman et al. (2020).

The most salient insights from the pilots regarding digitalization are as follows:

- **Prepare for data transfer:** Often, digital technologies require data to be transferred to the technology company's own cloud to analyze it via algorithms, AI, or other forms of advanced analysis. In some of the pilot projects presented, the water utilities faced technical problems such as inability to extract and receive data, lack of real time data, and difficulties uploading data to the cloud. Therefore, utilities should prepare all the necessary data, tackle technology issues, and involve their IT department in the initial stages of the process.

- **Operationalize the technology**: In an effort to implement new technologies, some utilities try to adopt technologies without the buy-in from their operational teams. If the operational teams are not involved from the start, they might not prioritize the technology or facilitate implementation. Hence, a high-level executive in charge of operations should be nominated to oversee execution. This champion should understand the advantages of the technology, see its potential and foster adoption at an operational level.

- **Build capacity support:** The ability of the operational team to adopt the technology requires continuous capacity building throughout its implementation. Creating a behavioral change in the workplace is not easy, and requires will power and effort, hence should be implemented throughout the pilot project.

3

Contributions to successful piloting and scaling innovation

This section seeks to answer the second research question: ii What insights can be drawn from these pilots that can contribute to scaling innovation in WSS utilities in LAC? It examines the case studies' success as it pertains to achieving the stated results of the pilot, and potential for scaling (whether it be the public service provider adopting the technology or service model using its own funds, or the potential for application of the same solution across the country or region). These contributions to successful piloting and scaling innovation in each country and in the rest of the region are based on the lessons learned through evaluation of the innovation pilots (Section 2.2) and through the lens of the innovation management in WWS model (Section 1.2.1).

3.1 Success in achieving stated goals

All the cases reviewed here were successful in achieving the desired results of the pilot. As it relates to the evaluation framework, having the operational/implementation unit and the decision-maker onboard proved key not only to trying new solutions in the utilities, but to having those solutions achieve the desired results (**desirability**). Utilities needed not only the technological preconditions for the pilots to take place, but also the human capacity (in the form of training, knowledge, and dedication) to implement the pilots (**feasibility**). Finally, while these pilots were funded through international cooperation agreements, viability was not necessarily dependent on profitability, but rather on the economic return or financial ROI and a utility's budget or ability to access funds (**viability**).

Success for the cases analyzed varied, from being clearly outlined in the beginning through KPIs, to being simply stated as a proof of concept. Those that established clear KPIs at the beginning had brought operational teams quickly onboard and made headway presenting their results to upper management, making the case for the solution (increasing desirability). CAJ, for example, used Brazil's National Information System on Sanitation (Sistema Nacional de Informações sobre Saneamento, SNIS) indicators as KPIs, and went from having monthly data for each DMA to having an online, integrated system with data and analysis capability for the entire network. The pilot showed the potential for proactive leak management, integrating information from the network, and having a dashboard that provides network event alerts. In the case of SADM, leakage level indicators and reduction efforts were established in conjunction with Asterra and allowed a before and after comparison. Thanks to the information, SADM was able to estimate a one month ROI in using this technology to proactively detect and repair leaks (saving 55 L/s in the process). In the case of EAAB and SEDAPAL, the pilots were successful as proof of concept. For EAAB, Kando detected pollution events, achieved real-time monitoring of select network parameters, and allowed the utility to build a case against polluters with evidence collected. Operational managers at SEDAPAL were able to use the system for several months and see the benefits of detecting network events. In both examples, there is a case being built to expand the pilot.

In all cases, proof of concept yielded satisfactory results that made the solutions desirable and outlined the necessary steps to make them technically feasible – whether by increasing telemetry, improving data management, involving more operational and IT teams, or increasing district and micro-metering. At the time of this writing, we are not yet able to state whether the utilities possess the budget or the mechanisms to make these solutions viable. The results, potential savings, and potential benefits are encouraging, however.

3.2 Internal culture of innovation within utilities

The utilities' day-to-day internal operations often prevent managers, boards, and operational teams from thinking about innovation. Changes in leadership and general management make continuity of innovation difficult. Internal structure and bureaucracy may also affect the ease with which a utility's staff and teams are able to innovate.

3.2.1 Promoting a culture of innovation

In certain cases, the utilities had dedicated innovation departments that were very involved in the design, selection, and implementation process. In one case, the utility had its own process for assessing new technology. Once the new technology began to show results, the utility asked the solution provider to undergo the assessment so the utility could proceed with implementation. In each case, the dedicated department or process for innovation contributed to the ease of developing an innovation pilot.

In addition to a dedicated department or process for integrating new solutions into the utility's operation, it was key to involve all internal stakeholders in design and implementation. Doing so from the pilot planning stage helps ensure that the innovative solution used by the utility has the dedicated capacity it needs. In a few cases, additional units in the utility (i.e., not the main end user) joined the pilots at later stages of the implementation process. Having them participate from the planning stage rather than jumping into the project when there was already an established timeline would have made implementation smoother. Tying the work they performed for the pilot to their work plan and indicators associated with it would also ensure more buy-in from these units, who would then no longer view the innovation or pilot as extra work they needed to do.

3.2.2 Planning for and beyond the innovation pilot

Having clarity on the utility's challenge will help it design and select an adequate solution. It will also help dedicate adequate resources on both the utility and solution provider side. This includes having an appraisal of the size and nature of the challenge, an analysis of the different available options, and taking an honest look at a utility's technical and human capacity to implement a solution. For the latter, for example, the existence of DMAs, micro-metering, telemetry, and IT systems played a key role in the pilots looked at. In the case of EAAB, the topology of the network was validated during implementation. Had it been validated during the planning stage, less reworking would have been needed during implementation. Additionally, a maintenance crew was added later during the pilot. Time would have been saved if that crew had been part of the project since inception. The case of CAJ, for example, highlighted the importance of having data available. Yet despite having years of data, there was still significant effort required to make it available in the format needed for the piloted solution.

Planning helps ensure the necessary technical capabilities are in place. In the case of SADM and EAAB, the utilities were well developed and had high technical and human capacity to receive the new technology. This facilitated smooth implementation and the ability to respond to the needs of the pilot, which allowed the operational teams to take ownership of the solution and clearly see its application and usefulness. For these two utilities, strong alignment with current priorities also contributed to the likelihood of these pilots extending beyond the initial phase.

Planning beyond the pilot will increase the likelihood of uptake of the new solution beyond the initial phase. Having a clear strategy and goals that align with a utility's long-term plan as well as with a unit's work plan, will contribute to the ability to tie the achievements of a new solution to the utility's bottom line and improve demand from the implementation teams. In the case of SADM and CAJ, for example, it became clear during implementation that the pilots were in line with a longer-term strategy for leak reduction.

3.2.3 Establishing clear goals and aligning them with broader goals

Clear goals help create determinants for success and possible scaling, especially because they can establish benchmarks to indicate whether pilot implementation was successful (Section 3.1). In the cases of SADM and CAJ, the utilities had clear, measurable KPIs the pilot needed to achieve which helped present a business case to upper management and leadership. In SADM, operational teams saw the benefit of reducing the search area for leaks, while a one-month ROI and significant physical loss reductions presented a clear case for management. In CAJ, the president viewed the results as encouraging and expressed interest in the piloted system allowing the utility to have an integrated management system, better operate the network, and receive early alerts on network events.

3.3 External factors and the innovation ecosystem

Utilities operate in a complex environment, subject to governance frameworks and demands, relationships with contractors, and collaboration with international donors. This ecosystem can help or hinder their ability to implement new solutions for their day-to-day and service challenges.

3.3.1 Governance framework

In all the cases presented here, national processes needed to be considered, and a national government-issued statement of no objection and approval were required for the pilot to be implemented with the IDB. However, implementation of these pilots through IDB procurement mechanisms also allowed for easier procurement. In one of the countries, public procurement is quite complex and makes contracting new solution providers almost impossible. For single source selection, there are many criteria that need to be met, and through implementation, many additional government institutions participate in controlling and auditing. In all cases where hardware and equipment needed to be imported, there were challenges with bringing things into the country, leading to delays. Finally, in one of the cases, the fact that regulatory and compliance agencies as well as other public entities were involved in similar efforts as those addressed through the pilot facilitated the ease with which the pilot was implemented.

External pressures also help determine the level of demand for a particular solution. For SADM, reducing physical losses in the face of drought and scarce resources continues to be of utmost importance, while for EAAB, monitoring and controlling pollution discharge aligned with the priorities of the utility and its regulatory agencies. In both cases, these proved important in pursuing the innovation pilot and finding ways to scale.

3.3.2 Relationship with contractors

All four projects experienced implementation challenges due to differences in language and time zones. For Kando (EAAB) and Asterra (SADM), having a local consultant as a link also helped address these differences and offered the solution provider with an understanding of the local context.

Utilities find it hard to trust external agents with new technology and sensitive operational data. One of the benefits of having a benefactor like the IDB and TC for these kinds of trials is that it reduces the utilities' risk in piloting a technology that has not been tried. In the case of SADM, for example, the technology was accepted as a concept early on, and SADM was willing to adopt and change. In other cases, there were concerns over confidentiality of the data to be shared with the solution provider that were resolved through mediation with IDB and strict confidentiality agreements. The IDB's strict rules also enabled the pilots to be under constant monitoring.

Trust and communication can also be built through in-person interactions. The pilots included in this document were implemented while there were still significant health restrictions in place due to COVID-19 were still in place. As such, in-person meetings and visits from the Israeli companies were limited. More personal interactions between the donor, the utility, and the company would have been beneficial. As one of the stakeholders put it, "in the end, you do business with people," so there is a limit to what can be achieved without personal interactions – the ability to meet, share, and discuss – to create trust between the different parties and have clear expectations. In-person interactions, and especially having a counterpart that is familiar with the local policies and business context, help clearly identify the utilities' pain points and how to address them.

3.3.3 International cooperation

Donors can contribute to reducing risk by providing an initial source of funds for viability, and overall improve the innovation ecosystem for utilities.

Using donor funds for a pilot can lower both the financial cost and the risk of innovation for utilities. If an innovative solution shows results, particularly if these represent significant savings in time or physical losses (as was the case in all the pilots presented here), utilities can use these savings to pursue scaling of the solution on their own.

Using donor procurement processes, utilities can conduct market analyses on the different solutions available for their specific challenge and pursue a new solution they deem most adequate for testing. This contrasts with going through public procurement mechanisms, which are generally not designed for innovation but rather for generic cost/quality selection processes. At the same time, donors can take lessons learned from these processes and collaborate with other countries to foster a more enabling environment for utilities to innovate in.

Donors can help foster knowledge about innovative solutions in the sector and make the case for innovation. Knowledge exchanges and learning events from innovation pilots can generate knowledge among utilities and sector organizations. Leak detection and reduction, for example, is something that every WSS utility must deal with. However, it is hard for utilities to determine what an appropriate new technology is without first understanding the context in which it can be useful: the level of SCADA and metering that is required, the level of information that a tool needs to work (like IOSight), or the loss profile for satellite technology (like Asterra) to work. Private sector companies also need to understand the local context and utilities' needs. Private companies, especially those foreign to the region, often lack an understanding of local business culture, how public utilities function and what they need, and public procurement processes.

Multilateral development banks (MDBs) like the IDB can have an important role in sector governance to foster innovation. In Colombia, for example, all utilities face the same regulations as EAAB, and could benefit from a solution that allows them to comply. Each utility, however, has its own process for innovation. MDBs can bring the experience from other countries to apply innovation broadly – for example, in Israel, wastewater intelligence is used country-wide for epidemiological surveillance.

4 Conclusions

Several factors affect utilities' ability to implement new solutions, pilot them successfully, and move from piloting to full-scale use of innovation. These factors are related to how much demand for the solution there is from end-user units and upper management (desirability), to the utilities' technical and human capacity to use these new solutions (feasibility), and to the budgetary and ecosystem constraints utilities face (viability). The governance framework can also be conducive to the utilities' ability to scale.

Lessons learned from implementing innovation pilots offer valuable insights as to how WSS utilities in LAC can implement new solutions in a way that will ensure a pilot's success, as well as offer the possibility to scale. From the utilities' experiences presented here, it is clear that an important contributor to improving uptake of new solutions is early involvement of the implementing unit, decision-makers, and the utilities' complimentary units in defining the challenge faced by the utility, as well as in selecting the solution, and planning its implementation (including KPIs and indicators relevant to the workplan of the units involved in implementation).

Cases like that of Monterrey and Bogotá, where the decision-maker and implementing unit were the same, illustrate the importance of this alignment. Meanwhile, the CAJ and SEDAPAL pilots strengthen the case for early involvement of all users, as the onboarding of other units during the implementation process presented additional challenges.

Ensuring that the utility has the necessary technical and human capacity preconditions is key as well and involving all the necessary units from the beginning will ensure seamless implementation. This was evidenced in the CAJ and SEDAPAL cases, which needed to ensure their data was properly stored and shared with the solution provider. In the case of EAAB, certain telemetry equipment was identified as faulty and needed replacement. In the case of SEDAPAL and SADM, having dedicated leak repair units to act on the information provided through the solution provider was essential to capitalizing on the new information.

Finally, whether using its own or external resources, the ROI of the innovation is key to ensuring scalability and use of an innovation beyond the piloting stage. For SADM the financial return from a reduced search area and leak reduction was easily seen. For SEDAPAL, the potential savings were also evidenced. In all cases, aligning the pilot with the bottom line and utilities' longer-term objectives can help ensure that there is return on investment, as well as contribute to the possibility of scaling.

WSS utilities do not operate in a vacuum. Their ability to innovate is related to their internal processes (innovation culture, expectations, goals, opportunities, selection, implementation, portfolio, evaluation and structure of innovation) and tied to their context (society, sector governance, innovation ecosystem, and environment).

Pilots are important for testing out new solutions and reducing risks in innovation. Successful pilots with clearly stated key outcomes help build a case for innovating to scale. Integrating piloting and innovation into a utility's development and work plans can also contribute to taking new solutions beyond the pilot stage into implementation at scale as part of the utility's operations.

Annexes

Annex 1. Key questions and considerations for successfully piloting innovation in WSS Utilities

Based on the innovation pilot case studies analyzed, the following set of questions can help utilities and the stakeholders who work with them plan for successful and scalable pilots:

Desirability

It is recommendable to involve the implementation unit, additional units needed in implementation, and decision-makers in the definition of the challenge, the selection of the solution, and planning for the pilot. Ideally, all stakeholders should be consulted when defining the challenge, selecting the solution, and determining the pilot's goals. The following questions can help guide that process:

- Is the implementing unit (the final user of the new solution) clear on the challenge the utility is facing?
    - Is the decision-maker?
- Does the implementing unit want to implement the new solution?
    - Does the decision-maker?
    - Are the complimentary units (other units needed to deploy the new solution) onboard?
- Have the goals of the pilot been aligned and incorporated into the work plans of the implementing and complimentary units?
- Do the goals of the pilot align with the long-term goals of the utility (general management, board, etc.)?

Feasibility

Both technical preconditions and the human capacity need to be in place for an innovation pilot to be carried out successfully. To that end, the following questions can help guide the process:

- Does the utility have the necessary telemetry equipment in place to implement a new solution? (SCADA, DMAs, macrometering, micrometering, testing)
    - Can it be implemented during the pilot?

- Does the utility have the necessary data management capabilities in place (how/in what format is the data stored, can it be shared)?
    - Can these data management processes be improved during the pilot? As part of the pilot?
- Is the implementing unit sufficiently capable of implementing the pilot?
    - Are there any capacity-building activities that need to be carried out?
- Does the utility have other units that need to be involved in the pilot?
    - Do they have the capacity to support implementation?
    - Have their efforts and time been considered in the pilot?
    - Are there any capacity building activities needed?

Viability

The economic viability of a solution is key. Although utilities may not initially have the funds needed to test out a new solution, they may seek funds from international cooperation agreements or national entities. Regardless, the solutions for future viability should be considered:

- Does the utility have the funds needed to implement the solution that addresses its particular challenge?
    - Can it obtain external funds to pilot the solution?
- Does the solution, a priori, present the possibility of return on investment?
    - Can the savings or returns from the solution be used to continue its implementation after the pilot?
- Have KPIs been put in place so that pilot success can be measured, as it relates to the utility's bottom line?
    - Can an ROI be calculated for the innovation pilot, and projected if scaled?

Scaling

Ensuring the desirability, feasibility, and viability of an innovation pilot contribute to its successful implementation, which can help ensure its scalability. However, additional considerations may help:

- Is the innovation pilot part of a longer-term management or development plan?
- Are the pilot's goals, objectives, and KPIs aligned with the utility's longer-term plans?
- Can the utility secure its own funds for scaling the innovative solution after the piloting phase?
- Are the proper governance arrangements available for the utility to proceed with the innovation after the pilot?
    - Can it obtain funds in addition to its own?
    - Are the proper procurement mechanisms available for the utility to continue after the piloting phase?
    - Can the utility take on the risk of scaling the innovation, or are there regulatory procedures that need to be considered first?

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