

COLLABORATIVE ARRANGEMENTS IN WATER AND SANITATION: A CASE STUDY IN PARANÁ SANITATION COMPANY – SANEPAR

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Highlights:

- Open Innovation strategy based on collaborative arrangements with startups.
- The relationship between open innovation, knowledge absorption and sustainable innovation.
- The impact of the new legal framework for basic sanitation on sustainable innovation.
- Deepening the analysis of open innovation and learning in the sanitation sectors.

Keywords: Open Innovation; Startups; Learning.

INTRODUCTION

This paper highlights the importance of collaborative arrangements among institutions such as universities, public-private companies, regulatory agencies, startups, and Paraná Sanitation Company (Sanepar). The general objective was to address *how* open innovation can enhance knowledge absorption capacity and improve performance in sustainable innovation in collaborative arrangements through the *Environmental Sanitation Open Innovation Program - Sanepar Startups*.

Collaborative arrangement refers to the evolutionary set of actors interconnected to develop technological capability, knowledge, or skills for innovative performance (Grandstrand & Holgersson, 2020). Also, this work adopts open innovation as the engagement of the organization with external sources of knowledge to develop innovation (Chesbrough, 2024). Furthermore, learning here is understood as the translation of local project experiences into general knowledge, rules, and norms, thus creating knowledge flows (Kurpjuweit & Wagner, 2020).

The demand for new knowledge mainly emerged from the New Basic Sanitation Regulatory Framework in 2020, when the Brazilian government stimulated investments in Public-Private Partnerships (PPP). The sector's reform aims to provide universal access to Brazilians who are not connected to sewage collection systems. Additionally, the regulatory effect of the basic sanitation legal framework, based on performance, can encourage the development of capabilities (Teece, Pisano & Shuen, 1997), forcing the appropriation of new technologies in already established companies (Hurmelinna-Laukanen, 2014, 2009). Therefore, the water and sanitation sector, faced with the amount of development of necessary technologies, requires filling gaps in specialized knowledge for innovations. Moreover, Brazil must accelerate and intensify studies on innovation, as the country currently has limited representation in technological development (Dantas da Silva & Cavalcante de Amorim, 2023). In fact, there is a gap in understanding the sources of sustainable innovation in the water and sanitation sector in emerging economies.

The thematic perspective falls under the areas of innovation, education, training, and certification within this scope, adopting a micro-level, qualitative approach (Miles, Huberman & Saldaña, 2020), open innovation, learning, and knowledge absorptive capacity. Additionally, the study sheds light on how an emerging economy combines external sources of knowledge to improve performance in sustainable innovation. Thus, the study contributes to a deeper understanding and analysis of open innovation and learning in the water and sanitation sectors of other emerging economies.

METHODOLOGY

Specifically, the study aims to investigate *how* open innovation and learning can enhance knowledge absorption capacity, to improve performance in sustainable innovation. As represented in Figure 1.

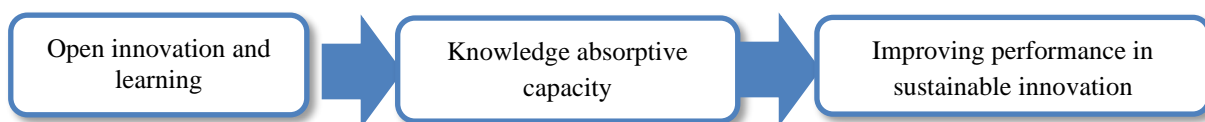


Figure 1- Analytical framework of this study

The analytical framework illustrates the links between the essential dimensions of the study examined at Sanepar and startups participating in the *Environmental Sanitation Open Innovation Program - Sanepar Startups* between 2020-2024. The research methodology prioritized a single case study (Yin, 2018), and the data collection involved fieldwork, and participant observation in workshops, which provided valuable opportunities for informal acquisition with potential interviewees. It also involved recording semi-structured interviews conducted with engineers, researchers, and technicians at Sanepar, as well as those responsible for the startups. Additional evidence was obtained through electronic archives and documents. The combination of direct observation and interviews provided excellent bases for capturing the interaction of procedures, and performance of the role of projects as intermediaries at knowledge flows. The evidence was submitted to a qualitative rating scale adapted from Clausen & Hafkesbrink (2005) to assess the desired direction of the indicators related to the technologies developed by the startups. These assessments were based on the new regulatory framework for sanitation and Sanepar's technology eligibility process, including: i) optimization of production processes with an emphasis on sensing and automation technologies; ii) resilient and sustainable infrastructure, considering sustainable technologies for water, sewage, sludge, and waste treatment; iii) water resources and climate, focusing on remote sensing and decentralized systems with microgrids; iv) improvement in customer relations, using technologies for interactive management to enhance customer experience and environmental education; v) reduction of water loss by using performance indicators as a regulatory target for efficient operation.

RESULTS AND CONCLUSIONS

The preliminary results contribute to the theoretical and empirical understanding of *how* open innovation in collaborative institutional arrangements intensifies technological innovation in the sanitation infrastructure sector of an emerging economy. The drivers behind technology development provided a basis for understanding the desire for a positive technological trajectory, highlighting the importance of real projects such as experiments and the adaptation of technologies in the sanitation sector in Paraná. The evaluation of the projects, based on sustainability criteria, was crucial for accurately perceiving various concepts related to sustainable innovation. Moreover, knowledge absorption occurred through experiential learning in projects and face-to-face interactions between the Sanepar mentoring team and the entrepreneurs of the collaborating startups. This abstract presents a specific project involving technology that monitors water pressure in the water distribution network to

identify leaks. The technology, based on artificial intelligence, has made the water distribution process more efficient, reducing both internal and external waste of the company's resources. In practice, the technology has achieved the trade-off between cost and quality for sustainable innovation through the use of algorithms for leak control. With real-time water loss monitoring, Sanepar can mobilize maintenance teams to precisely locate leaks, making the service faster and more cost-effective. The project provides valuable evidence to explain the effects of collaboration and mentoring in the co-development between Sanepar and the startup. As of October 2023, the project has recovered 491 m³ of water per day, reduced electrical energy consumption by 98,484 kWh/year, and avoided 895 tCO₂e/year in carbon emissions. The technology developed has positively impacted performance indicators for sustainable innovation, according to the qualitative evaluation scale. As a result, the startup selected through the *Environmental Sanitation Open Innovation Program – Sanepar Startups* has entered a new phase of collaboration with Sanepar, under the Startups Law (Complementary Law No. 182, of June 2021), to continue using the developed technology to reduce water losses. The evidence suggests that the potential impacts of the technology evaluated within the analytical framework demonstrated strong efficiency, effectiveness (in terms of the quality/cost trade-off), improvement, and flexibility of the system being enhanced. In the environmental criterion, the reduction of treated water loss was the technological innovation that led to the startup being selected as a supplier of services for Sanepar during the screening and acceleration process. This research addressed the capacity for knowledge absorption through open innovation, focusing on collaborative learning practices and experimentation and the influence of new knowledge on enhancing performance in sustainable innovation. The collaborative arrangements involved cooperation between Sanepar's team which served as the project mentor, and a startup team included engineers specialized in artificial intelligence. Additionally, a senior researcher with a PhD in computational mathematics was dedicated to researching the state-of-the-art technology to be developed.

Also, a Sanepar's technological capacity, based on previous experiences, proved to be influential in performance within the sanitation sector. In the *Environmental Sanitation Open Innovation Program - Sanepar Startups*, project mentoring positively impacted the performance of sustainable innovation. It can also be considered that Sanepar effectively utilized its accumulated knowledge stock to improve internal processes, achieving this with speed and at reduced development costs. The ability to absorb knowledge was demonstrated in practice through the day-to-day operations of mentoring innovation projects selected in the Program. For example, specialist engineers alternated roles as rapporteurs and mentors for projects aimed at reducing water loss, with peer evaluation becoming a routine part of research and development.

In conclusion, this study highlights the importance of new technologies organized around Sanepar, emphasizing the significance of knowledge flows within a collaborative arrangement and the satisfactory results achieved in acquiring and exploring technological innovation. This involved integrating the technological base of institutions into the collective technological knowledge of the infrastructure and basic sanitation sector. Consequently, the study makes significant contributions to the literature on innovation and firm-level knowledge absorptive capacity in several ways. First, the applicable model distinguishes between i) open innovation and learning; ii) absorption and knowledge base; and iii) performance in sustainable innovation, contributing to the understanding of which performance indicators are relevant for the basic sanitation sector within the context of the new Regulatory Framework for Basic Sanitation. Second, it examines how an established company can quickly acquire new knowledge. Third, the study addresses a gap in research on open innovation within sanitation companies in emerging economies.

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