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# THE MEDIATING ROLE OF ABSORPTIVE CAPACITY BETWEEN EXTERNAL SOURCES OF KNOWLEDGE AND INNOVATION PERFORMANCE: A CASE STUDY IN AN ELECTRICITY COOPERATIVE

## O PAPEL MEDIADOR DA CAPACIDADE ABSORTIVA ENTRE FONTES EXTERNAS DE CONHECIMENTO E DESEMPENHO EM INOVAÇÃO: ESTUDO DE CASO EM UMA COOPERATIVA DE ELETRICIDADE

## EL PAPEL MEDIADOR DE LA CAPACIDAD ABSORTIVA ENTRE FUENTES EXTERNAS DE CONOCIMIENTO Y RENDIMIENTO EN INNOVACIÓN: ESTUDIO DE CASO EN UNA COOPERATIVA DE ELECTRICIDAD

**ABSTRACT**

**Objective:** This study investigates the mediating role of absorptive capacity between external sources of knowledge and product innovation performance within the context of an electricity cooperative.

**Design/Methodology/Approach:** Conducted with a quantitative methodology, the study involved administering a questionnaire to 82 supplier companies of an electricity cooperative, using the Partial Least Squares (PLS) method to test the structural model.

**Results:** The findings indicate that external sources of knowledge, mediated by absorptive capacity, have a significant and positive association with the performance of product innovation. Organizations need to utilize both scientific and industrial external sources of knowledge to develop both potential and realized absorptive capacities, in order to perceive financial, market, technical, customer, and strategic benefits from innovation.

**Originality/Value:** This highlights the strategic importance of knowledge management in maintaining competitive and innovative organizations in the current business environment. In this sense, the study addresses the need for organizations to develop practices related to knowledge absorption, emphasizing that these practices not only allow for the acquisition of relevant business information but also facilitate the propagation and transformation of routines, leading to improvements in products and services.

**Keywords:** Absorptive Capacity. External Sources of Knowledge. Innovation Performance. Electricity Cooperatives. Knowledge Management.

Silvio Parodi Oliveira Camilo
PhD.
Universidade do Extremo Sul Catarinense- Brazil
parodi@parodiconsultoria.com.br

João Vânio Mendonça Cardoso
PhD.
Universidade do Extremo Sul Catarinense- Brazil
jvcardoso@unesc.net

Jaime Dagostim Picolo
PhD.
Universidade do Extremo Sul Catarinense - Brazil
jdpicolo@gmail.com

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## RESUMO

**Objetivo:** Este estudo investiga o papel mediador da capacidade absortiva entre fontes externas de conhecimento e o desempenho em inovação de produtos no contexto de uma cooperativa de eletricidade.

**Design/Metodologia/Abordagem:** Realizado com uma metodologia quantitativa, o estudo envolveu a aplicação de um questionário a 82 empresas fornecedoras de uma cooperativa de eletricidade, utilizando o método Partial Least Squares (PLS) para testar o modelo estrutural.

**Resultados:** Os resultados indicam que as fontes externas de conhecimento, mediadas pela capacidade absortiva, têm uma associação significativa e positiva com o desempenho da inovação de produtos. As organizações precisam utilizar tanto fontes de conhecimento científico quanto industrial para desenvolver capacidades absortivas potenciais e realizadas, a fim de perceber benefícios financeiros, de mercado, técnicos, de clientes e estratégicos da inovação.

**Originalidade/Valor:** Destaca a importância estratégica da gestão do conhecimento para manter as organizações competitivas e inovadoras no ambiente de negócios atual. Nesse sentido o estudo aborda a necessidade de as organizações desenvolverem práticas relacionadas à absorção de conhecimento, enfatizando que essas práticas não só permitem a aquisição de informações relevantes para o negócio, mas também facilitam a propagação e transformação de rotinas, levando a melhorias em produtos e serviços.


**Palavras-Chave:** Capacidade Absortiva. Fontes Externas de Conhecimento. Desempenho em Inovação. Cooperativas de Eletricidade. Gestão do Conhecimento.


## RESUMEN

**Objetivo:** Este estudio investiga el papel mediador de la capacidad absortiva entre fuentes externas de conocimiento y el rendimiento en innovación de productos dentro del contexto de una cooperativa de electricidad.

**Design/Metodología/Enfoque:** Realizado con una metodología cuantitativa, el estudio involucró la aplicación de un cuestionario a 82 empresas proveedoras de una cooperativa eléctrica, utilizando el método de Mínimos Cuadrados Parciales (PLS) para probar el modelo estructural.

**Resultados:** Los hallazgos indican que las fuentes externas de conocimiento, mediadas por la capacidad absortiva, tienen una asociación significativa y positiva con el rendimiento de la innovación de productos. Las organizaciones necesitan utilizar fuentes externas de conocimiento científico e industrial para desarrollar capacidades absortivas potenciales y realizadas, con el fin de percibir beneficios financieros, de mercado, técnicos, de clientes y estratégicos de la innovación.

**Originalidad/Valor:** Esto destaca la importancia estratégica de la gestión del conocimiento para mantener organizaciones competitivas e innovadoras en el entorno empresarial actual. En este sentido, el estudio aborda la necesidad de que las organizaciones desarrollen prácticas relacionadas con la absorción de conocimiento, enfatizando que estas prácticas no solo permiten la adquisición de información relevante para el negocio, sino que también facilitan la propagación y transformación de rutinas, llevando a mejoras en productos y servicios.


**Palabras clave:** Capacidad Absortiva. Fuentes Externas de Conocimiento. Rendimiento en Innovación. Cooperativas Eléctricas. Gestión del Conocimiento.

## INTRODUCTION

With the advancement and spread of technological innovations and rapid access to information, organizations have considered knowledge as one of the main strategic resources. They employ this knowledge in improving processes, products, or services and in prospecting for innovation (Wiig, 1997). For an organization to be considered competitive, it is necessary for knowledge to be identified, absorbed, and managed in a way that facilitates access to and utilization of this information, thereby generating innovation and minimizing the impact on the internal and external environment (Cohen & Levinthal, 1990; Nonaka & Takeuchi, 1995).

In this context, the literature indicates that the capacity to identify, acquire, understand, and apply external knowledge directly influences an organization's performance and innovation capacity (Zahra & George, 2002; Todorova & Durisin, 2007). This process is recognized and conceptualized as the absorptive capacity of knowledge, considered a dynamic capability (Zahra & George, 2002). The concept of absorptive capacity was extensively grounded in the studies of Cohen and Levinthal (1990). These authors described absorptive capacity as an organization's ability to absorb new external knowledge and apply it for commercial purposes. For Daghfous (2004) and Fichman (2004),

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absorptive capacity is defined as an organization's ability to acquire and effectively use external and internal knowledge that influences innovations. This concept expanded in foreign literature and was also incorporated by Brazilian scholars (Rossetto *et al.*, 2019).

Organizations cannot rely solely on their external networks but also need to develop their absorptive capacities to actively obtain knowledge (Matthyssens *et al.*, 2005). These organizations require approaches and mechanisms to learn, disseminate, and exploit knowledge that can lead to new organizational innovations (Daghfous, 2004). Thus, many organizations face challenges in benefiting from external knowledge flows, even those with easily accessible information sources (Cassiman & Veugelers, 2006; Escribano *et al.*, 2009). Versiani *et al.*, (2021) explored absorptive capacity and external knowledge sources in their study. They highlight the relationship between external knowledge and innovation, noting that few studies explore the relationship between external and internal factors on innovation performance. This research selected the external factor of absorptive capacity and explored its relationship with innovation performance in the context of suppliers of an electricity cooperative.

The study aims to investigate the mediating role of absorptive capacity between external sources of knowledge and product innovation performance within the context of an electricity cooperative's suppliers in Santa Catarina. Given the significance of constructs representing external knowledge sources, absorptive capacity, and innovation performance, this study examines these phenomena within the context of an electricity cooperative in Santa Catarina, Southern Brazil. This region is home to most of Brazil's electricity cooperatives (OCB, 2022). This study seeks to address research gaps, as indicated by Dávila, Durst, and Varvakis (2018), and Cassol et al. (2019), and to contribute to the literature in two ways: first, by examining the mediation between the flow of external knowledge and absorptive capacity with innovation performance and empirically exploring these relationships; second, by contributing to an emerging body of literature on the outcomes of absorptive capacity. It aims to enhance understanding of phenomena such as the development of absorptive capacity and its impact on innovation performance, particularly for companies serving as suppliers to electricity cooperatives. Organizations develop innovations by learning from their partners, customers, and suppliers through relationship learning. Authors like Dávila, Durst, and Varvakis (2017) and Cassol et al. (2019) also emphasize the need for studies to further characterize absorptive capacity and knowledge sources in the Brazilian context, as the number of studies analyzing their contributions to innovation in organizations in countries like Brazil is still limited. This study innovates by exploring the existence of a relationship between external knowledge sources mediated by absorptive capacity and the innovation performance of suppliers to electricity cooperatives. It employs the hypothetical-deductive method to derive and propose hypotheses, through dimensions and categories of analysis that seek to relate, developing a conceptual analysis model for this research. The constructs considered are contextualized and will be presented in the next section.

The article is organized into five sections. After the introduction, the next section will present the theoretical framework and research hypotheses, discussing the relationship between absorptive capacity, external knowledge sources, and innovation, and the conceptual development and hypotheses. A description of the methodological procedures will follow this. After the discussion of the results, the final considerations will be described.

## THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

In this section, the research hypotheses regarding external knowledge sources, absorptive capacity, and innovation performance are presented.

### External Knowledge Sources and Absorptive Capacity

In the contemporary knowledge-intensive business environment, companies increasingly depend on external knowledge sources to foster innovation and improve performance (Cassiman & Veugelers, 2006; Morgan & Berthon, 2008). However, many of them face significant challenges in benefiting from external knowledge flows, even in organizations with easily accessible information sources (Cassiman & Veugelers, 2006;

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Escribano *et al.*, 2009). The literature suggests that absorptive capacity is related to external knowledge and internal factors (Zahra; George, 2002). Supporting this claim, Tortoriello (2015) highlights three internal factors considered in this association: organizational knowledge (the set of skills and experience of the organization), formalization (internal knowledge and rules), and integration (practice to reduce information exchanges). Research by Vega-Jurado, Gutiérrez-Gracia, and Fernández-de-Lucio (2008) also shows that organizational knowledge, measured by the level of education and activities in R&D, has a positive effect on absorptive capacity.

To possess scientific knowledge, it is required to have more technical training than industrial knowledge to develop absorptive capacity (Vega-Jurado *et al.*, 2008). Furthermore, R&D activities are more efficient if the knowledge is scientific, whether for acquisition or utilization (Bagchi-Sen & Lawton Smith, 2014). Formalization is positively associated with the acquisition and exploitation of scientific knowledge but is less significant for industrial knowledge (Vega-Jurado *et al.*, 2008). Absorptive capacity consists of two structural factors: a) a science-driven factor based on scientific information, and b) another market information factor, called demand-driven (Bagchi-Sen & Lawton Smith, 2014). R&D training is positively related to industrial and scientific capabilities, however, its importance differs if the capacity is demand-driven or science-driven (Kim *et al.*, 2018). The authors also describe that knowledge exploitation practices are specific to each type of knowledge, and external sources result in different types of innovation.

Gao et al. (2022) emphasize that the relationship between External Knowledge Sources and Absorptive Capacity is one of interdependence. External sources of knowledge provide the raw material, ideas, and information that can be transformative. However, without absorptive capacity, this knowledge remains underutilized, as the company is unable to effectively incorporate it into its operations or innovation strategies. Conversely, high absorptive capacity without an adequate flow of external knowledge limits the company to its existing knowledge base, which may be insufficient in a business environment that is constantly changing. According to Shehzad et al. (2022), 'External Sources of Knowledge' provide new and diverse information and insights from outside the organization, and 'Absorptive Capacity' acts as a key mechanism that allows the company to assimilate, understand, and efficiently apply this external knowledge in its operations and innovation processes, transforming external ideas into tangible and strategic innovations, both incremental and radical, within the organization.

For Kim et al. (2018), experience and external knowledge sources, as well as the pursuit of knowledge, can expand the absorptive capacity of organizations. In this context, the following hypothesis is presented:

***H1.*** *External sources of knowledge have a positive relationship with absorptive capacity***.**

## Absorptive Capacity and Innovation Performance

To overcome the difficulty of benefiting from external knowledge flows, organizations need to develop their absorptive capacity, that is, the ability to recognize the value of new information, assimilate it, and apply it for commercial purposes (Cohen & Levinthal, 1990). Gradually, the concept of absorptive capacity has gained recognition as one of the key drivers of a company's competitive advantage (Lichtenthaler, 2009).

Regarding the relationship between absorptive capacity and innovation performance, hypothesis construction draws from a range of seminal to contemporary authors. For Cohen and Levinthal (1990) and Zahra and George (2002), for instance, absorptive capacity is an important antecedent to innovative performance. However, the individual aspect of this process is highlighted by Cohen and Levinthal (1990), who state that individuals increasingly rely on their knowledge capabilities to continually innovate to improve their work-related performance. The studies of Zahra and George (2002) emphasize that innovation is directly related to realized absorptive capacity, while potential absorptive capacity is responsible for strategic choices. They also note that high potential absorptive capacity does not necessarily translate into innovation results. Conversely, Lowik *et al.*, (2017) investigated the diversity of prior knowledge, network diversity, and cognitive styles about absorptive capacity and innovation performance of employees and

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managers in medium and large companies.

Potential absorptive capacity is an antecedent of realized absorptive capacity, which in turn affects the relationship with innovation (Murovec & Prodan, 2009). Other authors like Choi and Park (2017) explicitly describe the importance of internal communication flows for innovation activities, and Tortoriello (2015) asserts that external knowledge leads to innovation through realized absorptive capacity. Theoretically, realized absorptive capacity is an important process that fosters innovation (Arbussà & Coenders, 2007). Hurtado-Palomino et al. (2022) propose that absorptive capacity eases the acquisition and assimilation of external knowledge. This facilitation enhances interactions between internal and external actors and transforms knowledge into tangible innovations through strategic reconfiguration and information exchange, thus bolstering organizational innovation capabilities.

Lyu et al. (2022) describe absorptive capacity as a key mechanism transforming social capital into effective knowledge search beyond company boundaries. This transformation enables companies to not only discover but also to effectively integrate new information into their operational and innovation strategies, resulting in more robust and adaptive innovative performance. Kastelli et al. (2022) view absorptive capacity as a critical link that turns digital capacity into concrete innovation. It mediates and amplifies the positive impact of adopting digital technologies, allowing companies to integrate and apply newly acquired knowledge to produce tangible innovative results.

Fulgence et al. (2023) contend that absorptive capacity enables companies to effectively utilize acquired external knowledge, which is vital for spurring innovation, particularly in industrial clusters where network collaboration and access to shared resources are crucial for success. Bindra et al. (2023) argue that absorptive capacity propels innovation performance by empowering organizations to not just recognize the value of new external information but also to assimilate and apply it effectively. This process involves sequential stages of learning: identifying and understanding new information (exploratory learning), spreading and assimilating this information within the company (transformational learning), and finally, using the internalized external knowledge to generate new insights (exploitative learning). This continuous cycle of absorbing, adapting, and applying external information catalyzes innovation, transforming external knowledge into innovative products, services, and processes within the organization. Accordingly, the following research hypothesis is declared:

***H2.*** *Absorptive capacity has a positive relationship with innovation performance.*

## External Knowledge Sources, Absorptive Capacity, and Innovation Performance

Different types of collaboration are necessary for the development of various types of innovation, with each partner bringing their perspective and accessing different sources of knowledge and information (Haus-Reve *et al.*, 2019). Therefore, it is crucial to understand which external knowledge sources are relevant to achieve different innovation outcomes (Haus-Reve *et al.*, 2019). Previous studies differentiate external knowledge flows from market-based and science-based actors (Danneels, 2002; Du *et al.*, 2012). Empirical literature shows that market-based actors are important sources of knowledge for innovation outcomes (Faems *et al.*, 2005; Hughes *et al.*, 2009; Lasagni, 2012; West & Bogers, 2014).

The search for knowledge considers market and science sources (Kim *et al.*, 2018). Evaluating innovation performance is crucial for innovation management, focusing on innovation (Blindenbach-Driessen *et al.*, 2010), and is a multidimensional measure given the multiplicity of meanings associated with performance measurement (Hannachi, 2015). Obtaining knowledge from suppliers aids in framing innovation possibilities, considering their knowledge of materials, equipment, and techniques (Kaufman *et al.*, 2000). However, knowledge flow with suppliers may vary in different value chain activities (Theyel, 2013).

Some researchers explicitly highlight the importance of external knowledge flows for innovation activities (Choi & Park, 2017). Tortoriello (2015) emphasizes that external knowledge opens up possibilities for innovation in organizations. Similarly, Kim *et al.*, (2018) demonstrate that

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external knowledge sources result in different types of innovation. Organizational knowledge, formalization, and integration are associated with an organization's absorptive capacity (Zahra & George, 2002; Tortoriello, 2015). Absorptive capacity, in turn, is an important process that drives innovation (Arbussà & Coenders, 2007), and the importance of internal communication flows is also relevant for innovative activities (Choi & Park, 2017).

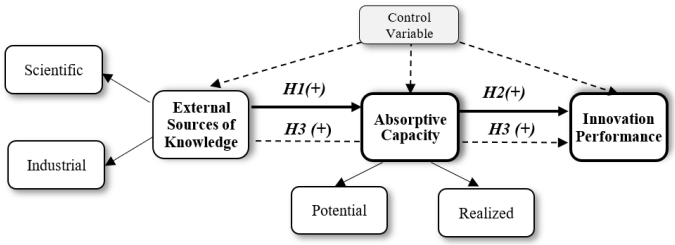
For Khraishi et al. (2023), external sources of knowledge not only enhance a company's ability to create internal knowledge but also to effectively exploit external knowledge. This relationship improves a company's innovative performance and operational efficiency. The integration of internally developed knowledge with externally absorbed knowledge through absorptive capacity leads to better innovation outcomes and overall performance in SMEs. Tippakoon et al. (2023) state that the relationship between external sources of knowledge and absorptive capacity is particularly significant in contexts where innovation is complex and requires a broad range of information from various sources. Companies seeking knowledge from a diverse range of actors tend to have higher innovative performance, as this increases the likelihood of encountering useful and diverse information, essential for innovation. Naqshbandi and Jasimuddin (2022) assert that External Sources of Knowledge are linked to 'Absorptive Capacity' by enabling the company to effectively utilize external knowledge resources. These managerial ties aid in the acquisition and leveraging of external knowledge and ideas, enhancing the organization's absorptive capacity, allowing it to integrate and effectively apply this external knowledge in its operations and innovation strategies.

In this context, it is essential to investigate which external knowledge sources are most relevant to achieving different innovation outcomes, given that external knowledge flows are crucial for innovation (Choi & Park, 2017; Haus-Reve *et al.*, 2019). Thus, it is believed that external knowledge, mediated by absorptive capacity, has a positive relationship with innovation performance (Tortoriello, 2015). Therefore, the following research hypothesis is established:

***H3.*** *External knowledge sources, mediated by absorptive capacity, have a positive relationship with innovation performance.*

The research design (Figure 1) was developed based on the theoretical discussions that underpin the research hypotheses H1, H2, and H3. The dimensions investigated are external sources of knowledge, absorptive capacity, and innovation performance, which are represented in the structural model as latent variables.

**Figure 1.** Research design




## RESEARCH METHODOLOGY

The study is classified as hypothetical-deductive regarding its method. It deduces constructs and categories from the literature, formulates causal relationships, and tests them. Thus, hypotheses emerge from theoretical construction (Cooper & Schindler, 2003). A quantitative approach was chosen as it is indicated for discovering and verifying relationships between variables and enabling multivariate data analysis (Lazzarotti, 2012). The research is both descriptive and exploratory, aiming to describe facts and phenomena of a specific reality and expose characteristics of a certain population, in addition to allowing for the correlation between variables and defining their nature (Kneipp *et al.*, 2011; Alves, 2012). The research strategy is characterized as a survey, as it seeks to measure values, opinions, knowledge, and behavior (Dalto, 2007).

The electric sector has been showing advancements in technological innovations, especially in alternative sources of renewable energy. According to Andoni et al. (2019), these changes have primarily occurred due to the integration of small-scale renewable sources (e.g., residential), service flexibility, and increased consumer participation in the energy market (prosumer), affecting various segments of the sector. Understanding the dynamics

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between absorbed knowledge and its effects on innovation, through agents of a constantly changing sector segment, is of interest to the present study. Data collection was conducted in October 2022, obtaining a total of 82 responses, corresponding to a response rate of 18.9% from the research population of 449 suppliers of an electricity cooperative in Santa Catarina, who had transactions in the last three years, thus reaching active suppliers. A post hoc test was conducted after applying the research using G*Power. For a medium effect (f2 = 0.15), a significance level of 5%, and a maximum of five predictors, the test's power is 95.07%, exceeding the 80% recommended by Faul et al. (2009) to consider the statistical test results of hypotheses as relevant. Data collection was supported by the cooperative, which sent an email to its suppliers requesting collaboration in responding to the online questionnaire and provided names and contact phone numbers of the suppliers for encouragement and reinforcement in responding to the questionnaires. The questionnaires were sent to be answered by the person responsible for the innovation area within the structure of the organization studied. A pre-test was applied to some suppliers, and some semantic adjustments were necessary. The collected data were transcribed into electronic spreadsheets and then analyzed using Structural Equation Modeling (SEM) through the Partial Least Squares (PLS) method, using the SmartPLS software version 4.0. The data were organized, synthesized, and presented, allowing for interpretation.

The construct measurements described in the appendix are structured in External Sources of Knowledge, Absorptive Capacity, and Innovation Performance.

External sources of knowledge are a second-order construct based on Murovec & Prodan (2009) and Vega-Jurado *et al.*, (2008), featuring two dimensions: scientific (3 indicators) and industrial (3 indicators). A 7-point Likert scale was used, ranging from 1 for "Strongly Disagree" to 7 for "Strongly Agree".

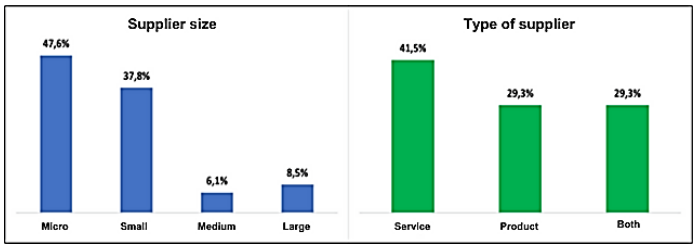
Absorptive capacity is a second-order construct based on Camisón & Forés, (2010), with two dimensions and 6 indicators: potential (3 indicators) and realized (3 indicators). A 7-point Likert scale was used, ranging from 1 for "Strongly Disagree" to 7 for "Strongly Agree".

Innovation performance is a first-order construct based on Hannachi (2015) with five indicators examining financial, market, technical, customer, and strategic benefits. Responses were collected using a 7-point Likert scale, ranging from 1 for "Outcome not achieved" to 7 for "Perfectly achieved".

## DISCUSSION OF RESULTS

Regarding the size of the companies in the sample, according to the classification of the Brazilian Institute of Geography and Statistics (IBGE, 2015), it was represented by 47.6% of micro-enterprises (up to 19 employees), 37.8% of small businesses (20 to 99 employees), 6.1% of medium-sized enterprises (100 to 499 employees), and large enterprises (above 500 employees) represented 8.5% of the sample. Regarding the type of supplier, the sample was represented by 41.5% of service suppliers, 29.3% of product suppliers, and 29.3% of both. The sample characterization can be verified in Figure 2.

**Figure 2.** Sample characterization




### Evaluation of the Measurement Model

This first stage of evaluating the measurement model involved analyzing the reliability of the data to ascertain if the model levels are considered acceptable. In the initial model, factor loading was analyzed, aiming to purify the data for latent variables. As an adopted criterion, loadings with external loads lower than 0.70 were removed from the scale. Table 1 presents the results of the initial and final models with the values of reliability (CR) and validity (AVE).

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**Table 1.** Constructs of the initial and final model

| Construct | Dimension | Indicator | Initial Model | | | Final Model | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Loading | CR | AVE | Loading | CR | AVE | CR | AVE |
| Absorptive capacity | potential | ACY1 | 0.751 | 0.770 | 0.480 | 0.759 | 0.820 | 0.600 | 0.822 | 0.698 |
| | | ACY 2 | 0.402 | | | - | | | | |
| | | ACY3 | 0.678 | | | 0.708 | | | | |
| | | ACY4 | 0.848 | | | 0.848 | | | | |
| | realized | ACY5 | 0.814 | 0.820 | 0.550 | 0.830 | 0.850 | 0.660 | | |
| | | ACY6 | 0.782 | | | 0.814 | | | | |
| | | ACY7 | 0.806 | | | 0.798 | | | | |
| | | ACY8 | 0.516 | | | - | | | | |
| External sources of knowledge | scientific | ESK1 | 0.903 | 0.890 | 0.680 | 0.915 | 0.940 | 0.830 | 0.896 | 0.812 |
| | | ESK2 | 0.932 | | | 0.932 | | | | |
| | | ESK3 | 0.559 | | | - | | | | |
| | | ESK4 | 0.857 | | | 0.882 | | | | |
| | industrial | ESK5 | 0.849 | 0.860 | 0.670 | 0.849 | 0.860 | 0.670 | | |
| | | ESK6 | 0.835 | | | 0.835 | | | | |
| | | ESK7 | 0.772 | | | 0.772 | | | | |
| Innovation performance | | INP1 | 0.707 | 0.860 | 0.560 | 0.707 | 0.860 | 0.560 | 0.860 | 0.560 |
| INP2 | | 0.730 | | | 0.730 | | | | | |
| INP3 | | 0.733 | | | 0.733 | | | | | |
| INP4 | | 0.748 | | | 0.748 | | | | | |
| INP5 | | 0.812 | | | 0.812 | | | | | |

The results show that the indicators of reliability (CR) and validity (AVE) for the constructs selected for the research exceed the minimum expected parameters (CR between 0.70 and 0.90 and AVE equal to or greater than 0.50) as recommended by Hair *et al.* (2022). For discriminant validity (Table 2), the Heterotrait-Monotrait ratio (HTMT) was used (Henseler *et al.*, 2015).

**Table 2.** Constructs of the Initial and Final Model

| Dimensions | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| (1) Scientific | | | | |
| (2) Industrial | 0.40 | | | |
| (3) Potential | 0.70 | 0.41 | | |
| (4) Realized | 0.46 | 0.40 | 0.73 | |
| (5) Innovation Performance | 0.41 | 0.27 | 0.51 | 0.41 |

Regarding discriminant validity, the Heterotrait-Monotrait ratio (HTMT) indicators show values below 0.90, thereby reinforcing discriminant validity, as suggested by Henseler *et al.* (2015). Another important point in the model evaluation is the influence exerted by control variables. The control variables used were: the company's time in business and company size. The test results indicated that the characteristics of the companies, represented by the control variables, did not have a significant effect on the relationships between the studied constructs.

## Evaluation of the Structural Model and Hypothesis Testing

The analysis of endogenous variables is the first step, explained by the coefficient of determination ($R^2$ and adjusted $R^2$), indicating the quality of the adjusted model. The effect size ($f^2$) or Cohen's indicator, which points out the relationship between the explanatory and non-explanatory parts, is also evaluated (Ringle *et al.*, 2015). Table 3 presents the structural indicators of the model related to innovation performance with absorptive capacity and external sources of knowledge.

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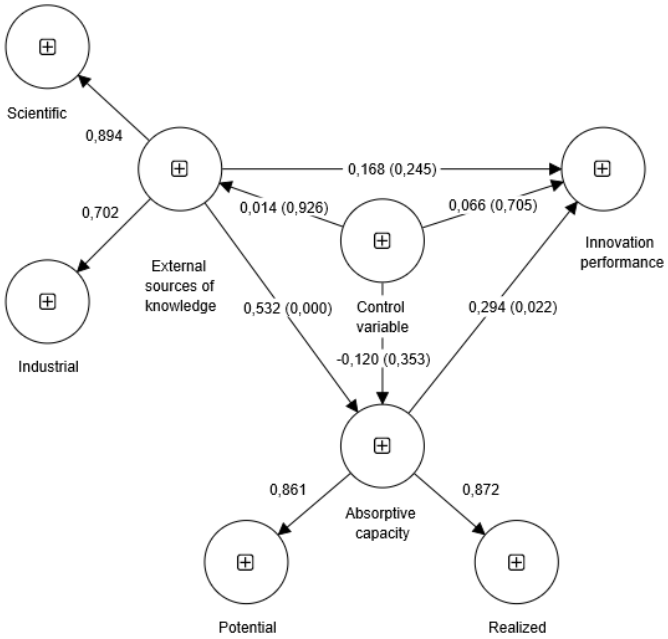
**Table 3.** Hypothesis Testing

| Structural Path | *f2* | Path Coefficients | Confidence Intervals | | *p-value* | Hypothesis Test |
|---|---|---|---|---|---|---|
| | | | 2.5% | 97.50% | | |
| H1 FC → CA | 0.402 | 0.532 | 0.351 | 0.685 | 0.000 | Supported |
| H2 CA → DI | 0.073 | 0.294 | 0.040 | 0.547 | 0.022 | Supported |
| H3 FC → CA → DI | 0.024 | FC → DI = 0.168 | -0.112 | 0.451 | 0.245 | Supported |
| | 0.402 | FC→ CA = 0.532 | 0.351 | 0.685 | 0.000 | |
| | 0.073 | CA → DI = 0.294 | 0.040 | 0.547 | 0.022 | |
| Control Variable | 0.000 | VC → FC = 0.014 | -0.281 | 0.285 | 0.926 | - |
| | 0.020 | VC → CA = -0.120 | -0.334 | 0.165 | 0.353 | |
| | 0.005 | VC → DI = 0.066 | -0.259 | 0.390 | 0.705 | |
| Coefficient of determination for "innovation performance" $R^2$ = 0.167 $R^2_a$ = 0.135 | | | | | | |

The coefficients of determination for $R^2$ and adjusted $R^2$ can be classified as substantial (0.75), moderate (0.50), or weak (0.25), however, there is no guideline on the size of $R^2$. Therefore, the crucial aspect is verifying the significance of the model containing at least one significant independent variable (Hair Jr. *et al.*, 2005).

Regarding the values of $f^2$ (effect size), the classification is as follows: (0.02) small value, (0.15) medium value, and (0.35) large value. The $f^2$ (effect size) signals a change in the $R^2$ determination coefficient concerning a potential omission of the independent variable. In light of the statistical validation regarding the aspects of reliability and discriminant validity of the constructs of the model studied in this research, Figure 3 presents the complete structural model.

**Figure 3.** Structural model of the research hypotheses




## Results and Discussions

According to the studies presented in the theoretical foundation, through external sources of knowledge, it was possible to verify the relationship with absorptive capacity (Kim et al., 2018), with potential and realized dimensions composing absorptive capacity (Camisón & Forés, 2010). The scientific and industrial dimensions comprise external sources of knowledge (Murovec & Prodan, 2009; Vega-Jurado et al., 2008). Regarding innovation performance, the dimensions were financial, market, technical, customer, and strategic, adapted from Hannachi (2015).

Understanding that the variable "external sources of knowledge" are sources that form the technical capability of the organization to also develop absorptive capacity, as the organization develops its absorptive capacity skill from the absorbed knowledge, thus aiming to achieve innovation performance. The analyzed hypotheses are discussed next. Upon acceptance of hypothesis H1, external sources of knowledge have a positive and significant relationship with absorptive capacity, contributing to the organization's pursuit of knowledge and development of absorptive capacity to achieve innovation performance. This corroborates the studies of Kim et al., (2018) which affirm that the

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pursuit of knowledge can expand the absorptive capacity of organizations.

With the acceptance of hypothesis H2, absorptive capacity has a positive and significant relationship with innovation performance, contributing to the understanding that absorptive capacity is considered a driver for achieving innovation performance. This is in line with the assertion by Arbussà & Coenders (2007) and Tortoriello (2015) that absorptive capacity is an important process that fosters innovation. Finally, with the acceptance of hypothesis H3, external sources of knowledge, mediated by absorptive capacity, have a positive and significant relationship with innovation performance, confirming studies that point out that external knowledge leads to innovation through realized absorptive capacity (Tortoriello, 2015).

Given that the suppliers of the cooperative have been positively influenced by the relationship of the studied variables, it can be inferred that external sources of knowledge (Kim *et al.*, 2018) and absorptive capacity (Zahra & George, 2002) are considered factors that drive innovation performance (Hannachi, 2015). This turns them into significant sources of competitive advantage for these organizations. As a consequence, and reinforced by Tortoriello (2015), who asserts that external knowledge leads to innovation, cooperatives, through external sources of knowledge and considering absorptive capacity as a present factor in the organization, enhances innovation performance. This transformation of knowledge into action becomes a valuable asset to provide and sustain the organization's competitive advantage. This emphasizes the crucial role of strategically managing knowledge resources and capabilities to stay competitive and innovative in today's business environment.

## CONCLUSION

This study aimed to analyze the influence of external sources of knowledge and absorptive capacity on innovation performance in the context of suppliers of an electricity cooperative in Santa Catarina, Brazil. Initially, the research verified and adapted validated scales best suited to measure these concepts. After defining and adjusting the scales for application to cooperative suppliers, the constructs were analyzed together to address the research question.

The findings revealed a significant relationship between external sources of knowledge and absorptive capacity with innovation performance. Additionally, the construct of external sources of knowledge positively correlates with absorptive capacity and its respective observable variables.
This indicates the necessity for organizations to develop practices related to knowledge absorption (absorptive capacity), as these practices not only enable the acquisition of business-relevant information but also facilitate the propagation and transformation of routines, leading to improvements in products and services.

Consequently, external sources of knowledge and absorptive capacity in an organization create a conducive environment for innovation. By developing absorptive capacity and utilizing external sources of knowledge, organizations also create conditions for enhancing their innovation process, indicating a correlation between the two. This may partly explain the competitive advantage some organizations have over others, as those improving their knowledge absorption abilities through external sources will enhance their innovation process, becoming less vulnerable to market adversities.

Confirming the interrelationship among the studied constructs contributes both theoretically and methodologically to understanding the nexus between external knowledge sources, absorptive capacity, and innovation performance. The empirical nature of this study enriches theoretical understanding, while methodologically, it examines the constructs' applicability in participant companies. This research endorses the use of latent variables in structural modeling, recognizing that a mediating variable can modulate the relationship between specific independent and dependent variables. Thus, the study found evidence of absorptive capacity's influence, derived from knowledge sources, on innovation processes. Investigating this theme in the electricity cooperative context addresses a market need to comprehend these construct interactions, aiming to advance organizational innovation performance.

The study's limitations include the reluctance of supplier companies to participate, possibly due to data confidentiality concerns or other unidentified factors. Another limitation

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was finding knowledgeable respondents within organizations, as the respondents might not have been the most qualified to answer the survey. The commitment level of respondents, influenced by personal or professional factors, might also affect the accuracy of the responses.

The research identifies gaps in the covered themes, opening opportunities for future studies with different constructs or expansions of the current ones. The study can also be replicated with suppliers from other regions and states to seek similar results or behavioral patterns. Future research could employ qualitative methods to understand existing practices in organizations and develop models encompassing these themes.

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## APPENDIX

Items composing the study scales.

| Dimension | Code | Scale of External Knowledge | Source of Literature |
|---|---|---|---|
| Scientific | ESK1 | Your company often uses knowledge from research centers to innovate. | Murovec and Prodan (2009) e Vega-Jurado; Gutiérrez-Gracia; Fernández-de-Lucio (2008) |
| | ESK2 | Your company often uses information from scientific conferences to innovate. | |
| | ESK3 | Your company often uses information acquired in business meetings to innovate. | |
| | ESK4 | Your company often uses information acquired from patent databases to innovate. | |
| Industrial | ESK5 | Your company often uses the knowledge of its suppliers to innovate. | |
| | ESK6 | Your company often uses the knowledge of its customers to innovate. | |
| | ESK7 | Your company often uses information from its competitors to innovate. | |
| **Dimension** | **Code** | **Absorptive Capacity Scale** | **Source of Literature** |
| Potential | ACY1 | Your company has the ability to capture relevant, continuous, and up-to-date information and knowledge about current and potential competitors. | Camisón and Fóres (2010) |
| | ACY 2 | Your company has an orientation towards management waiting to see what happens, rather than a concern and orientation to monitor the environment and continuously follow trends to proactively discover new opportunities to be explored. | |
| | ACY3 | Your company has the ability to assimilate new technologies and innovations that are useful or have proven potential. | |
| | ACY4 | Your company has the ability to develop knowledge management programs, ensuring the company's ability to understand and carefully analyze knowledge and technology from other organizations | |
| Realized | ACY5 | Your company has the ability to adapt technologies designed by third parties to the particular needs of the company. | |
| | ACY6 | Your company encourages all employees to voluntarily share useful scientific and technological information acquired among themselves. | |
| | ACY7 | Your company has the ability to use and exploit new knowledge in the workplace to quickly respond to environmental changes. | |
| | ACY8 | Your company seeks to innovate to gain competitiveness, expanding the portfolio of new products/services, capabilities, and technological ideas. | |
| **Dimension** | **Code** | **Innovation Performance Scale** | **Source of Literature** |
| Innovation Performance | INP1 | Profits attributable to new products/services are higher than those projected for the remaining products. | Hannachi (2015) |
| | INP2 | New products/services have enabled penetration into new markets. | |
| | INP3 | The quality of new products/services is better than that of the remaining products/ services. | |
| | INP4 | New products/services have improved customer loyalty. | |
| | INP5 | New products/services have improved the company's reputation | |