



EVALUATION OF SME RELATIONSHIPS FOR OPEN INNOVATION: PROPOSAL OF THE ARTIFACT ‘INNOVATION NETWORK ASSESSMENT TOOL’ (INAT)

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ABSTRACT

Objective: This research aims to develop an artifact that small and medium-sized enterprises (SMEs) can use to assess their network of relationships and identify partners for open innovation projects.

Methodology/approach: The Design Science Research (DSR) method was used to create the artifact, which is based on a theoretical model that incorporates three mechanisms for analyzing interorganizational relationships: richness, receptivity, and reach. Three tests were run on the artifact during development. Afterwards, an evaluative test was conducted with four companies to determine whether the developed artifact met its objective and had good operation and presentation.

Originality/value: In the absence of similar tools addressing the same class of problem, a new artifact was proposed, allowing SME managers to analyze their relationships and plan new open innovation projects.

Main results: According to preliminary evaluations, the artifact is adequate for understanding which partners can participate in an innovation project and how to channel resources, however, it needs to be supplemented with other tools that allow knowing the partners.

Theoretical/methodological contributions: As the research's main contribution, we present an operational artifact that is functional and well received by managers and has the potential to be used as an auxiliary tool in open innovation projects developed by SMEs.

Social/management contributions: As an implication for the field of open innovation in SMEs, we consider the identification of the problem and the proposal of an artifact as a relevant formulation for raising new hypotheses and developing subsequent artifacts.

Keywords: open innovation, small and medium-sized enterprises, design science research, relationship network.

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AVALIAÇÃO DOS RELACIONAMENTOS DE PMES PARA INOVAÇÃO ABERTA: PROPOSTA DO ARTEFATO INNOVATION NETWORK ASSESSMENT TOOL (INAT)

RESUMO

Objetivo: Esta pesquisa tem como objetivo desenvolver um artefato que pequenas e médias empresas (PMEs) possam utilizar para avaliar sua rede de relacionamentos e identificar parceiros para projetos de inovação aberta.

Metodologia/abordagem: O artefato foi desenvolvido por meio do método *Design Science Research (DSR)*, a partir de um modelo teórico baseado em três mecanismos de análise das relações interorganizacionais: riqueza, receptividade e alcance. Durante o desenvolvimento, foram realizados três testes para o artefato. Na sequência, foi realizado um teste avaliativo com quatro empresas para verificar se o artefato desenvolvido atingia seu objetivo e se tinha boa operação e apresentação.

Originalidade/valor: Na ausência de ferramentas semelhantes que abordassem a mesma classe de problema, foi proposto um artefato novo, que permite ao gestor de PMEs analisar seus relacionamentos e planejar novos projetos de inovação aberta.

Principais resultados: As avaliações preliminares indicaram que o artefato é adequado para perceber quais parceiros podem participar de um projeto de inovação e como canalizar recursos, mas precisa ser complementado com outras ferramentas que permitam conhecer os parceiros.

Contribuições teóricas/metodológicas: Como principal contribuição da pesquisa, apresentamos um artefato operacional, funcional e avaliado positivamente por gestores, com capacidade de ser ferramenta auxiliar em projetos de inovação aberta desenvolvidos por PMEs.

Contribuições sociais/gerenciais: Como implicação para o campo de inovação aberta em PMEs, consideramos a identificação do problema e a proposta de um artefato como uma formulação relevante para o levantamento de novas hipóteses e desenvolvimento de artefatos posteriores.

Palavras-chave: inovação aberta, pequenas e médias empresas, *design science research*, rede de relacionamentos.

EVALUACIÓN DE LAS RELACIONES PYMES PARA LA INNOVACIÓN ABIERTA: PROPUESTA DEL ARTEFACTO 'INNOVATION NETWORK ASSESSMENT TOOL' (INAT)

RESUMÉN

Objetivo: Esta investigación tiene como objetivo desarrollar un artefacto que las pequeñas y medianas empresas (PYMES) puedan utilizar para evaluar su red de relaciones e identificar socios para proyectos de innovación abierta.

Metodología/enfoque: El artefacto fue desarrollado utilizando el método *Design Science Research (DSR)*, basado en un modelo teórico basado en tres mecanismos para analizar las relaciones interorganizacionales: riqueza, receptividad y alcance. Durante el desarrollo, se realizaron tres pruebas para el artefacto. A continuación, se realizó una prueba evaluativa con cuatro empresas para verificar si el artefacto desarrollado alcanzaba su objetivo y si tenía buen funcionamiento y presentación.

Originalidad/valor: A falta de herramientas similares que aborden la misma clase de problema, se propuso un nuevo artefacto, que permite a los gestores de pymes analizar sus relaciones y planificar nuevos proyectos de innovación abierta.

Resultados principales: Las evaluaciones preliminares indicaron que el artefacto es adecuado para entender qué socios pueden participar en un proyecto de innovación y cómo canalizar los recursos, pero necesita ser complementado con otras herramientas que permitan conocer a los socios.

Aportaciones teóricas/metodológicas: Como principal aporte de la investigación, presentamos un artefacto operativo, funcional y evaluado positivamente por los gestores, con capacidad para ser una herramienta auxiliar en los proyectos de innovación abierta desarrollados por las PYMES.

Contribuciones sociales/de gestión: Como implicación para el campo de la innovación abierta en las PYMES, consideramos la identificación del problema y la propuesta de un artefacto como formulación relevante para plantear nuevas hipótesis y desarrollar artefactos posteriores.

Palabras clave: innovación abierta. pequeñas y medianas empresas. Design Science Research (DSR). red de relaciones.

1 INTRODUCTION

Chesbrough (2003) proposed the concept of "open innovation" as a new paradigm for organizational innovation management. Chesbrough and Bogers (2017, p. 28) describe it as "distributed innovation process that relies on purposively managed, inter-organizational knowledge flows". Researchers have been drawn to the field of study since the term was coined, with an exponential increase in references to the topic (Albats et al., 2020; Grama-Vigouroux et al., 2019; Hervas-Oliver et al., 2021; Nestle et al., 2019; Radziwon & Bogers, 2019).

Open innovation can benefit not only large corporations, but also small and medium-sized businesses by accelerating their innovation process through partner connections. These businesses contribute significantly to the Brazilian economy in terms of added value and job creation (Sebrae, 2020). Positive individualities of SMEs, such as flexibility, quick decision-making, and fast response to market demand, are offset by negative characteristics, such as a scarcity of human and material resources (Brunswick & van de Vrande, 2017), making open innovation a viable strategy for keeping them competitive in the market (Kleine et al., 2022; Lucia et al., 2022).

While the literature emphasizes the importance of open innovation for SMEs, the majority of scientific studies on the subject are geared toward large corporations (Brunswick & van de Vrande, 2017). Because of the differences between small and large organizations, findings from large-company studies cannot be easily applied to the context of SMEs (Brunswick & van de Vrande, 2017; Radziwon & Bogers, 2019). Considering it is difficult to transfer the results of research in large corporations to SMEs, these must be considered as a separate object of study.

Small and medium-sized enterprises (SMEs) rely heavily on their network of relationships to find the resources they need to innovate and expand their technological competencies, both during the development and commercialization phases of innovation (Brunswick & van de Vrande, 2017; Lee et al., 2010 ; van de Vrande et al., 2009). To be able to implement open innovation strategies, SMEs must first understand their network of relationships and the resources that can be accessed through it. Based on their bibliometric review, Dagnino et al. (2015) highlight the need to understand how companies manage and benefit from participation in interorganizational relationship networks, which can be organized in various types of arrangements for innovation, such as joint ventures, strategic alliances, industrial districts, and local productive agreements (Farias & Hoffmann, 2018).

Brunswick and van de Vrande (2017) believe that the conceptual relationship between interorganizational networks and innovation can be found in the literature, and affirm that ideas on how SMEs can purposefully use their relationships to take advantage of their social capital from inflows and output of knowledge within the paradigm of open innovation should be proposed. Buchele et al. (2015) conclude in a systematic review of methods, techniques, and tools for innovation that there are no guidelines and methodologies for implementing tools in different organizational contexts, reinforcing the need to direct studies to SMEs and seek to connect the concepts of interorganizational networks and open innovation.

This study proposes a solution for the difficulties associated with managing the network of interorganizational relationships of SMEs, with regard to taking advantage of these relationships for innovation, by analyzing the suggestions raised in the literature, understanding the importance of the network of relationships for SMEs (Lee et al., 2010), and the variety of levels of analysis, methodologies, and concepts introduced regarding their study. Hence, we believe that this tool's proposal addresses the classes of problems associated with open innovation management, interorganizational relationship network management in SMEs, and open innovation management in SMEs. In this context, the following research problem is presented: How can a small or medium-sized company evaluate other organizations in its interorganizational network to identify open innovation collaboration opportunities?

In search of this answer, the study aims to propose a tool for SMEs to assess their interorganizational relationship network and identify partners to develop open innovations.

To accomplish this goal, the Gulati, Lavie, and Madhavan (2011) model was used as a theoretical framework, which proposes three dimensions for the analysis of a network of interorganizational relationships: richness - the intrinsic value of the resources that the network provides; reach - the extent to which an organization's network of relationships connects it to

distant and diverse partners; and receptivity - how much the company is able to channel and take advantage of opportunities. The study was carried out using the Design Science Research (DSR) method, which is appropriate for the creation of artifacts, and the resulting tool advises SME managers on their innovation management processes and the possibility of entering into partnerships and open innovation projects, generating considerations about how these networks are structured, who their partners are, and what resources can be accessed through them.

2 THEORETICAL FRAMEWORK

The theoretical framework that supports this research is organized as follows: we present concepts related to open innovation in SMEs in Section 2.1, and we discuss aspects related to interorganizational relationship networks in Section 2.2.

2.1 Open innovation in SMEs

The use of ideas, resources, and knowledge that originate outside the company's borders is part of the open innovation concept, which Chesbrough coined in 2003 as a new paradigm for innovation management (Chesbrough & Bogers, 2017). This innovation paradigm seeks to broaden the ways in which businesses manage and benefit from contact with people and organizations outside their margins. It is assumed in open innovation that the company can intentionally manage internally generated knowledge and connect with external partners to innovate (Chesbrough & Bogers, 2017). The use of the company's generated knowledge is usually classified according to its direction in relation to the organizational boundaries: from the inside out (outbound), from the outside in (inbound), and both outside and inside (coupled) (West & Bogers, 2017).

According to Van de Vrande et al. (2009), Brunswicker and Van de Vrande (2017), and Hossain and Kauranen (2016), SMEs have different motivations to innovate than large corporations, and they particularly want to provide for their customers and become competitive. As a result, it is suggested that these studies be segmented based on the size of the companies. In Brazil, there are two recognized formal classifications to determine the size of companies: by the criterion of the Brazilian Support Service for Micro and Small Companies (SEBRAE), based on the number of employees, separated into micro companies (1 to 9 employees), small companies (10 to 49 employees), medium companies (from 50 to 99 employees) and large companies (more than 100 employees); and according to the BNDES criteria, based on annual revenues, divided into micro companies (less than or equal to BRL 360,000), small companies

(between BRL 360,000 and BRL 4.8 million), medium companies (between BRL 4.8 million and BRL 300 million) and large company (greater than BRL 300 million).

To date, the majority of studies on open innovation have concentrated on large corporations (Usman et al., 2018). According to Silva and Dacorso (2013), research focusing on small and medium-sized enterprises (SMEs) should be conducted in order to develop a specific model of open innovation, because "concepts arising from studies aimed at large companies and high-tech companies represent, many times, perspectives that are difficult to apply in companies that fit into a different competition context" (p. 265).

Small businesses' capacity to seek partners is limited (Lee et al., 2010), as is their ability to manage a commercial relationship (Hossain & Kauranen, 2016). Thus, SMEs have limited resources and the inability to obtain critical information and capital, making it difficult to select partners (Xiaobao, Wei and Yuzhen, 2013). Several studies have identified social relations and networks as catalysts for open innovation in companies, but they are limited by the same lack of resources that has been identified as the initial reason for seeking open innovation, whether for exploitation or exploration of technology and knowledge (Xiaobao et al., 2013).

The interest in a specific type of partner, such as a research institution or a client company, varies depending on the company's existing resources and what it hopes to gain from the alliance (Noh and Lee, 2015). According to Odriozola-Fernández, Berbegal-Mirabent, and Merigó-Lindahl (2019), SMEs have limited technical and financial resources to invest in research, as well as no formal R&D process. Therefore, pursuing a low-cost innovation strategy based on cultivating relationships with other businesses, customers, research institutions, and suppliers may be appealing.

Based on the inbound flow, Hervás-Oliver, Sempere-Ripoll, and Boronat-Moll (2021) present an assessment of the type of innovation proposed by SMEs, demonstrating that they innovate in both product and process development. The authors believe that strategic alignment with partners and the type of innovation sought are more important than the company's size or industry.

Barrett, Booley, and Bogue (2021) observe the adoption of open innovation as a paradigm for specific projects, with the return to a closed paradigm soon after the fulfillment of a specific demand, demonstrating the importance of selecting partners to carry out projects under the direction of open innovation.

A theoretical deepening of the concepts addressed in the field was sought based on a literature review, which began with a search for the terms open innovation AND SMEs, and open innovation AND networks in the scientific databases Science Direct and Web of Science.

For a better understanding of the phenomenon, related concepts in studies, and understanding of the demands and research results, articles on open innovation in SMEs were analyzed using quantitative methodology and organizational or interorganizational level of analysis. The quantitative method was used to identify studies that measure theoretical dimensions and could be used to create the tool in the subsequent stages of the research. Table 01 summarizes the findings of this review, considering open access articles, the variety of concepts studied, and adherence to this research:

Table

Synthesis of quantitative studies at the organizational and interorganizational level on open innovation in networks

Authors	Concepts	Hypotheses and starting points	Sample	Main findings and results
Laursen and Salter (2006)	Breadth and depth of research; opening; performance	Company openness in terms of breadth and depth of knowledge sources increases performance	Companies from different sectors and sizes in the UK	There is an inverted-U curve in terms of depth and breadth of sources of performance-related knowledge
Lee et al. (2010)	Description of the use of open innovation in SMEs; interaction of SMEs with a network intermediary	The limited ability of SMEs to search for partners	SMEs in South Korea	Proposal for a framework with an intermediary institution in a network that would connect SMEs for resources and build trust
Van Hemert, Nijkamp and Masurel (2013)	Performance in innovation, innovative competencies, sources of innovation, and sources of commercialization	SMEs collaborate to leverage their technology; there is a need for policies that encourage open innovation during the commercialization stage, which is especially important for SMEs	SMEs in the Netherlands	Proposal for a framework where innovative competencies, commercialization sources and innovation sources impact innovative performance
Xiaobao, Wei and Yuzhen (2013)	Organizational openness, information network, performance and innovative barriers	Certain SMEs have limited information resources and the ability to obtain critical information, making partner selection challenging	SMEs in China	Proposal for a framework where innovative capacity, innovative barriers, network openness and network information are related to innovative performance
Tomlinson and Fai (2013)	Innovative ties with customers, suppliers and competitors	Collaboration with customers, suppliers, and competitors can have a positive impact on SMEs' innovation	SMEs in the UK	Vertical chain cooperation (with suppliers and customers) increases innovative activity
Popa, Soto-Acosta and Martinez-Conesa (2017)	Environment of innovation; competitiveness and dynamism of the environment; inbound and outbound; performance	The influence of innovative climate and environment on forms of innovation and consequently on performance	SMEs in Spain	HR practices encourage the innovative climate, which in turn improves open innovation practices and performance
Noh and Lee (2015)	External collaboration partners, internal strategic activities	Understanding why companies decide to conduct external collaboration and with whom	SMEs in South Korea	Four main types of approach to external collaboration: discovering market opportunities, collaborative R&D, using internal resources, and acquiring strategic resources
Rehman (2017)	Two types of networks, with commercial and research partners; financial and non-financial performance	The correlation between network types and performance types	SMEs in Chile	Networks with commercial partners impact both types of performance; no correlation was found between search networks and performance

to be continued

Authors	Concepts	Hypotheses and starting points	Sample	Main findings and results
Pustovrh et al. (2017)	Open innovation information exchange and collaboration; innovative activities and innovativeness; marketing enablers	How information exchange and collaboration influence commercialization via innovative activities and innovativeness	High-tech SMEs in Slovenia	Collaboration impacts on innovativeness; internal resources limit innovative activities
Hinteregger et al. (2019)	Process, marketing, organizational innovation; inbound and coupled open innovation	The correlation between concepts and the distinction between medium and small company sizes	SMEs in Turkey	Inbound innovation process positively influences process and organizational innovation in small companies; Coupled innovation also influences these types, but more in medium-sized companies
Tseng et al. (2016)	Cohesion and density in the network; innovative capacity; network centrality	The correlation between network centrality and innovative capacity and network cohesion/density and innovative capacity	Global semiconductor market companies	The influence of network density and transmission of knowledge per patent on the company's innovative capacity
Ahn et al. (2016)	Openness, skills associated to open innovation, company performance	The correlation between concepts	Companies of different sizes in South Korea	Starting a business positively affects the development of open innovation skills

Source: Created by the authors (2022).

The review of articles that address open innovation provides an idea of the concepts employed by researchers. The adoption of some common measures of the company's level of innovative activity can be noted among the concepts used in the various studies: openness, absorption capacity, innovative capacity, and innovative performance. These metrics are constantly compared to innovative competencies, relationship network centrality, inbound and outbound processes, and interaction with the company's value chain (Laursen & Salter, 2006; Lee et al., 2010; Noh & Lee, 2015; Popa et al., 2017; Tseng et al., 2016; Xiaobao et al., 2013).

According to the bibliometric analysis performed by Dagnino et al. (2015), there is a growing field of research on innovation and inter-organizational relationship networks. The authors suggest that the performance of companies in their networks boosts innovative performance by providing more opportunities and skills. Dagnino et al. (2015) propose identifying how and under what conditions the network can be a strategic resource, as well as how executives can create these conditions, as a research agenda. As a result, the research on the dimensions of analysis of interorganizational relationship networks is being expanded in order to seek this increase in innovative capacity.

2.2 Interorganizational relationship networks

Interorganizational relationship networks are formed to benefit their participants and gain a competitive advantage over companies that do not engage in these relationships (Wegner, 2019). Organizations can gain scale and coordinate collective actions while remaining flexible within their lean size by participating in a network. Understanding that partnerships can benefit those involved and promote open innovation, particularly for SMEs, requires criteria for selecting and evaluating potential partners. These criteria were chosen from Gulati, Lavie, and Madhavan's (2011) concepts of richness, reach, and receptivity.

2.2.1 Analysis dimensions of the interorganizational relationship network

The evaluation of an organization's relationships is a way to manage potential partners and expanding the possibilities for achieving innovative performance. Gulati, Lavie, and Madhavan proposed three dimensions for evaluating interorganizational relationship networks: richness, reach, and receptivity (2011).

The **richness** dimension is defined as the value perceived in the attributes of the organization's network of relationships, i.e. the resources and knowledge to which the company

and its partners have access (Gulati et al., 2011). The rarity and usefulness of the network's resources are two characteristics of richness. Another factor to consider is appropriability, or the ability to access and transfer resources. Richness is also measured by how it contributes to organizational synergy: Bilateral and multilateral alliances combine internal and external resources, as well as resources from multiple partners (Gulati et al., 2011).

Dyer and Singh (1998) updated the resource-based view by including relational resources. They classify relational resources into two categories: appropriable resources that the firm can transfer to itself, and resources generated within the alliance. The ability of a company to appropriate a resource increases its richness because if it is unique or intellectually protected, it is less likely to have an impact on performance (Gulati et al., 2011).

Reach refers to the variety of organizational ties that a company can establish and manage. Gulati, Lavie, and Madhavan (2011) classify them according to their diversity, distance, and differences. The first factor is the distance between the company and its partner within the network structure. The second, distinction, indicates how distinct the partners are from the company itself. The last factor, diversity, is related to the first two: distances and various differences between partners in the relationship network.

The distance between the partner and the focal company within the relationship network characterizes structure-based interaction. A closer partner can more easily transfer knowledge and information to the focal company, increasing the efficiency of the alliance. Geographically and culturally diverse partners can provide unprecedented resources in the region where the company operates, improving its performance (Lavie & Miller, 2008).

Receptivity is defined as the company's ability to channel and leverage the resources offered by its network of relationships, as well as its transfer and appropriation capacity (Gulati et al., 2011). The receptivity mechanism is comprised of three components: trust, which generates predictability in relationships and negotiations; commitment, which is how much the partners and the company invest in and maintain long-term relationships; and the multiplexity of the generated ties, which is the number of individuals and units of each organization involved in the network and the amount of concurrent agreements maintained between the various parties.

Gulati and Sytch (2008) define trust as the expectation that another organization will fulfill its obligations to the alliance, behave predictably, and act and negotiate fairly even if it is opportunistic. Trust reduces governance costs such as contract formalization and reliance on third-party regulation while increasing organizational performance (Gulati & Nickerson, 2008).

Multiplexity has a similar effect, where more than one interpersonal relationship maintains the interorganizational relationship.

The three dimensions are proposed on the assumption that (Gulati et al., 2011) resources are brought to the forefront of interorganizational relationship networks (GULATI, LAVIE AND MADHAVAN, 2011). The authors contend that if a company invests in seeking new partners (reach), there is no automatic gain in targeting available resources in the relationship network, but rather that these interorganizational ties generate transactional costs. These costs must be offset by the alliance's benefits to organizational performance, which the company must be able to identify (richness) and channel (receptivity). Table 02 summarizes the concepts associated with each mechanism:

Table 2

Synthesis of concepts related to mechanisms of richness, reach and receptivity

Mechanism	Definition	Dimensions	Authors related
Reach	The resources that a company has available through its network of relationships	Diversity, distance and difference	Gulati (1999); Gulati and Gargiulo (1999); Lavie and Miller (2008), and Lavie and Rosenkopf (2006)
Richness	The inherent value of the resources available in the relationship network	Rarity/utility, appropriability and synergy	Ahuja (2000); Dyer and Singh (1998), and Lavie (2006)
Receptivity	Using and channeling perceived resources in the organization's network of relationships	Trust, commitment and multiplexity	Dyer and Singh (1998); Gulati and Nickerson (2008); Gulai and Sytch (2007); Gupta and Govindarajan (2000); Kale, Dyer and Singh (2002); Kale, Singh and Perlmutter (2000), and Khanna, Gulati and Nohria (1998)

Source: Created by the authors (2022)

3 METHODOLOGICAL PROCEDURES

Given that the general objective of this research is to propose an artifact that entrepreneurs and managers can use, the Design Science Research (DSR) method was chosen. This method "is positioned as an epistemological paradigm that can guide research aimed at problem solving and artifact design," according to Dresch, Lacerda, and Antunes Júnior (2015) (p. 52).

Dresch, Lacerda, and Antunes Júnior (2015) proposed the following steps for performing this method: 1) problem identification; 2) systematic literature review and problem

awareness 3) artifact identification and problem class configuration; 4) artifact proposal to solve a specific problem; 5) artifact design; 6) artifact development; 7) artifact evaluation; 8) acquired learnings explanation; 9) conclusions; 10) generalization to a class of problems and 11) communication of results.

In step 1, the problem is identified, the theme of study is defined, and the selection of this problem is justified considering its relevance and formulating the research's guiding question. This step has been detailed in section 1 and is based on the search for a solution to the limited capacity of small and medium-sized businesses to assess whether their partners have resources that may be interesting to begin an alliance within the open innovation paradigm.

This step produces "the formalization of aspects of the problem to be solved, including the consideration of its frontiers (external environment)" (p. 127), as well as "understanding and formalizing the necessary requirements for the artifact to be able to solve the problem" (p. 127). This step resulted in section 2.1 of this research, which details the current scenario for open innovation in SMEs. The assessment of SMEs' relationship networks based on their managers opinions was regarded as the research's frontier. That is, the research artifact included a self-assessment of the company, so that the manager could perceive and consider its own network of relationships, and with this knowledge absorbed, they may be able to decide where to focus your efforts and which relationships skills to improve.

A systematic literature review is proposed as step 2 of the method, which is proposed to gain a better understanding of the problem (Dresch et al., 2015). The systematic literature review method was used to map trends in the literature on open innovation in five articles (Bogers et al., 2017; Odriozola-Fernández et al., 2019; Radziwon & Bogers, 2019; Usman et al., 2018; West & Bogers, 2014). The utilization of the knowledge generated by these reviews sufficiently supported the research's awareness of the problem and served as the foundation for the elaboration and evaluation of the artifact developed.

To fulfill step 3, artifact identification and problem class configuration, the Web of Science and Scopus databases were searched for the existence of other artifacts aimed at SMEs interested in beginning to develop open innovation in their activities during the month of June 2020. By searching for the terms "open innovation" and "design science research," no previously published artifacts were found, limiting the configuration of the artifact's class of problems in relation to others. Afterwards, all works that cited the article by Gulati, Lavie, and Madhavan (2011) were reviewed in the Google Scholar and Science Direct (Scopus) databases during the second half of 2020. There was no study (Gulati et al., 2011) that applied the proposal of Gulati, Lavie, and Madhavan (2011) in instruments or artifacts, with the exception of a case

study that evaluated a company's relationships based on the three mechanisms (Falcone et al., 2019).

The researchers used this constraint to classify the artifact problem classes based on their own original proposal. The artifact proposal suited the problem classes of open innovation management, relationship network management in SMEs, and open innovation management in SMEs.

In step 4, artifact proposal to solve a specific problem, we sought to generate design suggestions to respond to the problem. This step is analogous, in natural science research, to the step where hypotheses are proposed based on an observation (Dresch et al., 2015; Manson, 2006).

An instantiation-type artifact was proposed, which “consists of a coherent set of rules that guide the use of artifacts (constructs, models and methods) in a given real environment” (Dresch et al., 2015, p. 112) to be improved and finished according to the development tests and evaluations carried out. The artifact was based on the following idea: to be able to present to the manager of a SME a way to evaluate their company's relationship network, to guide them in this evaluation, and, finally, to deliver a result that could be leveraged in their partner assessment when planning to innovate.

In accordance with step 5, the selected artifact design would be created from the artifact proposal. Following the creation of the initial version, at least three tests were carried out to improve the artifact.

The artifact was created in step 6. Due to the possibility of the software processing calculations, restrictions on researchers using more sophisticated programming languages, and possible restrictions on access and use by managers who performed the tests, it was decided to develop it as a program running within the Microsoft Excel software.

The analysis concepts of Gulati, Lavie, and Madhavan (2011) on interorganizational relationship networks were used to elaborate the artifact, which was divided into three mechanisms (see section 2.2). According to section 2.2.1, the artifact was created by developing a question for each of the nine attributes worked on by the original article, which are: trust, multiplexity, commitment, difference, distance, diversity, synergy, appropriability, and rarity. To elaborate on the questions, all works that cited the original article by Gulati, Lavie, and Madhavan (2011) were analyzed, and the concepts and terms used in these articles were adapted to questions that could be asked directly to managers through the artifact, in order to assess the network of relationships (Alinaghian & Razmdoost, 2018; Bai & Johanson, 2018; Cobeia et al., 2017; Gulati & Sytch, 2007). The authors translated terms, concepts, and questions based on

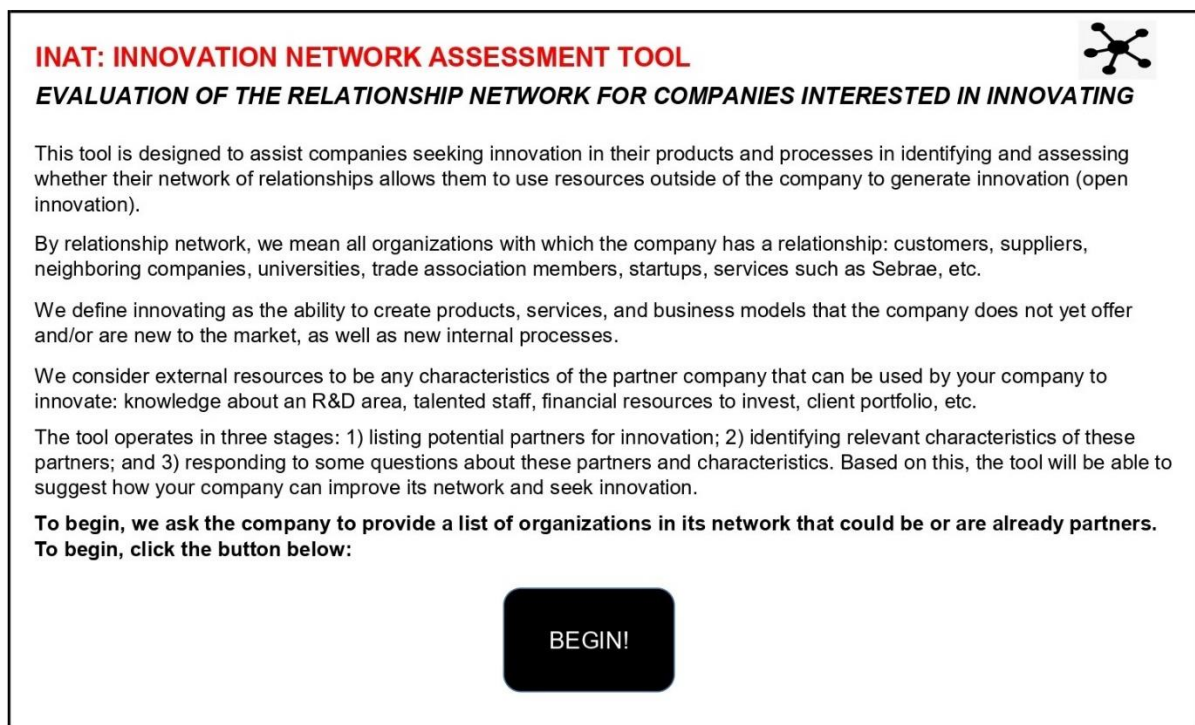
their reading of the original articles in order to maintain the proposed original meaning. There were no conflicts or doubts in the translated terms that necessitated special translation assessments. The text of the statements and their coherence were evaluated during the artifact evaluation process, as will be shown below.

Each question in the tool rates the partner and its resources on a scale of 1 to 5, with 1 indicating the least intense aspect of the evaluated matter and 5 indicating the most intense aspect of the evaluated matter. Based on this proposal, the tool was designed as a questionnaire that was administered in the following order:

- a) The company manager is introduced to the concepts that must be understood in order to use the tool correctly and receives the initial orientations (Figure 1).

Figure 1

Initial screen of the artifact developed



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Source: Created by the authors (2022).

b) As shown in Figure 2, the manager begins to insert the names of their closest or most useful partners for a partnership, separated by the categories Suppliers, Customers, and Others (where the other types of partners fit in). To make the tool dynamic and objective in this first stage, it was decided to limit the list to two "Suppliers," two "Clients," and four "Other" partners.

Figure 2

Screen for adding partners from the Suppliers category

List two suppliers with whom your company has a stronger affinity and trust, and/or who can collaborate to create innovation (new product or process):

1	Supplier 1
2	Supplier 2

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Source: Created by the authors (2022).

c) The respondent must then inform the company's resources that justify their selection, as well as the type of innovation (product, process, market, or managerial) to which they believe this resource can be applied. The screen guidelines explain each type of innovation (Figure 3).

Figure 3

Screen for adding resources from partners in the Suppliers category

List one or two of the most interesting characteristics of these suppliers in terms of innovation.
Examples: productive capacity, purchasing power for raw materials, product validation with customers, laboratory structure, etc.

Sort the attribute according to the types of innovation it can generate: Product innovation (starting to produce something that the company does not currently produce), process innovation (implementing a new process within the company), market innovation (opening a new market for the company), and managerial innovation (new management principles and work practices, company organization, management techniques, etc.).

Supplier 1	
Resource	Type of innovation
Resource 1	Product Innovation
Resource 2	Process Innovation

Supplier 2	
Resource	Type of innovation
Resource 3	Management Innovation
Resource 4	Product Innovation

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Source: Created by the authors (2022).

d) To complete the information insertion stage, the manager must answer questions based on the proposed dimensions richness, reach, and receptivity to evaluate each indicated partner and its resources (Figure 4).


Figure 4


Screen of one of the nine questions of the artifact developed

How does this partner differ from your company? (Think about everything you believe is important, such as industry, size, and target audience.)

Rate it from 1 (very similar) to 5 (very different).

Category	Partner	Grade
Supplier	Supplier 1	2
Supplier	Supplier 2	1
Customers	Customer 1	1
Customers	Customer 2	1
Others	Other 1	2
Others	Other 2	5
Others	Other 3	1
Others	Other 4	2





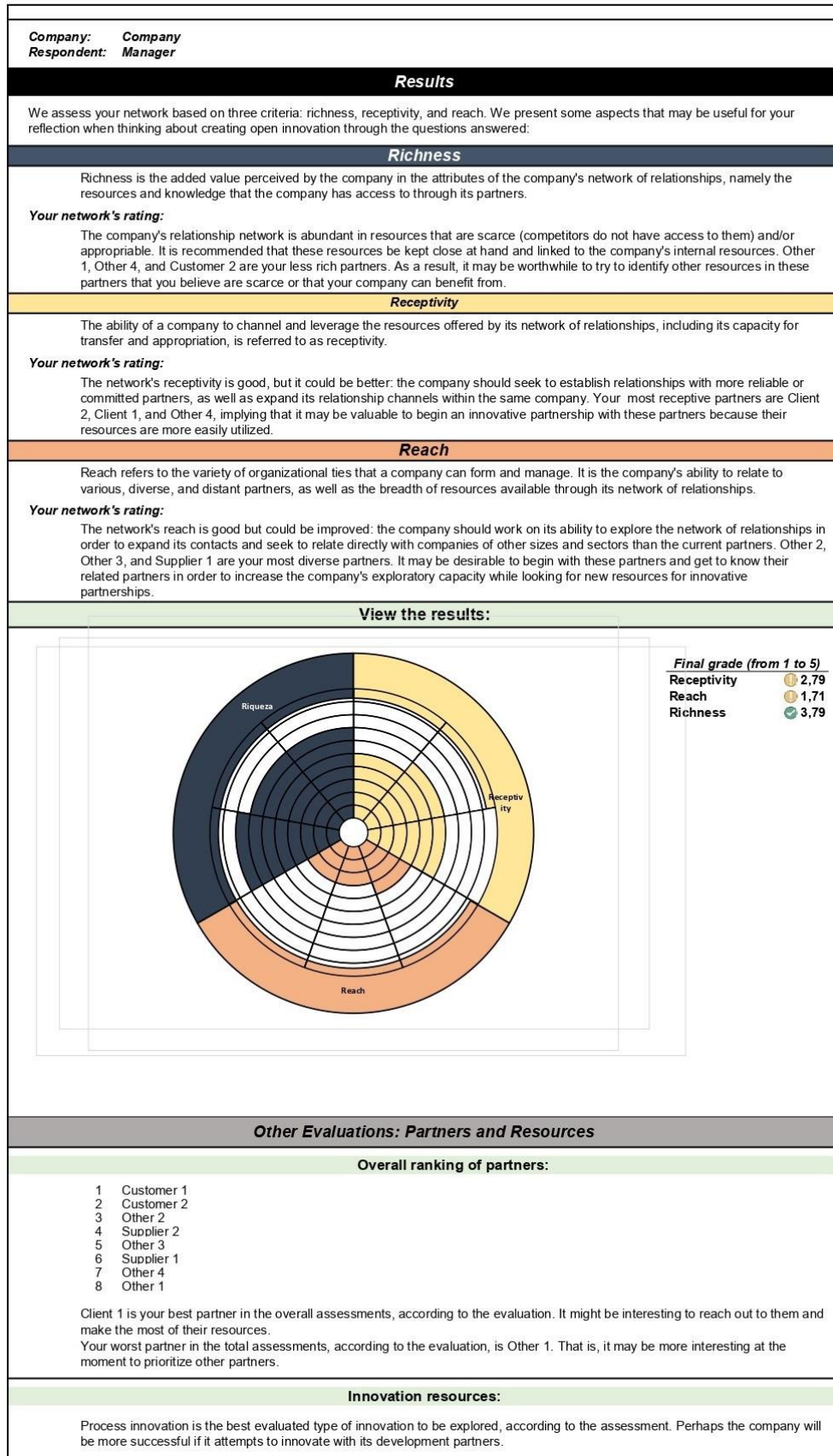
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Source: Created by the authors (2022).

e) As a result, the analyzed dimensions (reach, richness, and receptivity) and their evaluation based on the questionnaire on the results page (Figure 5) are presented to the company, assessing the company's network of relationships, its current state, and suggestions on how to improve. The manager can then print this report:

Figure 5

Result screen of the artifact developed



Source: Created by the authors (2022).

Three tests were carried out with different groups and methodologies, with the objective of changing the form and content of the artifact in different ways, according to Table 03:

Table 3

Sequential tests performed

Tool version analyzed	Type	Objective	Description	Participants	Summary of observations made	Changes Generated	Generated tool version
0.1	Exploratory focus group	To receive suggestions for enhancements and changes to the presentation and functionality	Open group in a round of considerations and suggestions	A group of six researchers in Administration	Writing description screens, terms used, and suggestions for adding completion screen results	Changing the texts described, the questions, and the final screen of results	0.2
0.2	Black box	To test the functionality of the tool with a manager	Use of the tool by a SME manager, accompanied by the researcher, to detect situations caused by its use	A startup director	Problems about how to navigate, doubts about how to answer certain questions, and suggestions for presenting results	Changes to the tool's navigation, to the wording of some questions, and to the presentation of new information on the final screen	0.3
0.3	White box	To validate whether the proposed questions are conceptually appropriate for what is being evaluated	We forward the form containing the test questions and concepts that each question is intended to measure, and we request that each question be evaluated against the concept	Four PhDs and one doctoral student in the area of cooperation and interorganizational networks	Changes to the wording of eight of the nine proposed questions to improve comprehension and summarize concepts	Changes to the wording of eight questions prepared for the tool	1.0

Source: The authors (2022).

The exploratory focus group was used for the first tool validation test (Dresch et al., 2015). It was held in October 2020 and was attended by a group of six Master's and Doctoral Business Administration students who were brought together by their interest in studying the DSR method. The goal of the test was to gather feedback on how to improve and correct the presentation and functionality. A week before the meeting, the tool was distributed to the group. Following a demonstration of use, the researchers presented their impressions of the artifact in a round of suggestions and notes at the meeting. The meeting lasted about an hour, and 34 suggestions were made. The researchers took notes on each suggestion and responded with responses and comments during the meeting, allowing participants to reinforce, change, or propose new suggestions.

The next test was carried out in November 2020, with the participation of a managing partner of a startup in the food tech segment, after updating the tool with the changes suggested in the previous step. The test was of the black-box type (Dresch et al., 2015), which means it was functional. The goal of the test was to ensure that the tool could be assimilated by a SME manager, how they would use it, and whether there were any issues with functionality or usability.

One of the researchers conducted the test, accompanying the manager while they used the tool and offering guidance when there was an error or confusion in navigation. The manager made thirteen suggestions, mostly about navigation, question wording, and the final results screen. The manager understood the presented results and agreed with the test's evaluation. They did, however, suggest that there be more detail on the concepts and guidelines identified by the tool. This suggestion was incorporated into the final results page. Questions have also been revised to improve comprehension.

The theoretical aspect of the artifact, i.e., the concepts presented and their relationship to the outcome, was evaluated in the final test, which was still in the tool's development stage. This final test was of white-box type, of internal consistency (Dresch et al., 2015; Manson, 2006). Four doctors and a doctoral student from the field of innovation and entrepreneurship were invited to validate the consistency of the artifact's questions. The scientists came from the fields of innovation research (management, orchestration, and platforms), economics, and entrepreneurship.

During the months of January and February 2021, an email was sent to the researchers containing a form that presented each of the concepts used in the tool as well as the question to be applied in the tool, asking the researcher to assess whether the question was in accordance with the concept and, if not, how it could be changed. The researchers made a total of 26

suggestions and comments on the questions and their adherence to the concepts. Except for one of the nine questions, all of the others were modified based on the responses of the interviewees consulted for this stage of the research.

When the questions were finished being edited, the artifact was updated to version 1.0, which was used in the research's final evaluation.

After the development tests were completed, the artifact was sent for final evaluation, and version 1.0 was created (step 7). For this step, four SME managers were invited to use the artifact's final consolidated version in a three-step test: first, they answered a previous questionnaire (company description), then they used the artifact, and finally, the managers answered a new post-use questionnaire evaluating the artifact's effectiveness, operational, and appearance aspects.

The research is completed based on the results of the artifact's development and evaluation. The results of the development and evaluation of the artifact are revealed in the conclusion section, as are the heuristics generated in these two steps (steps 8 and 9). Based on this knowledge, researchers can generalize the proposed solution and the knowledge acquired for a class of problems, allowing other researchers to use it in future research (step 10) (Dresch et al., 2015).

The final stage proposed by Dresch, Lacerda, and Antunes Júnior (2015) is the communication of results (stage 11), which includes the presentation of the research and its availability in databases so that it can be consulted by other researchers in the future, which is fulfilled by the dissemination of this article.

4 PRELIMINARY ANALYSIS OF THE ARTIFACT

When version 1.0 was created, the artifact was deemed ready for testing with managers in a preliminary controlled assessment based on the recommendations of Giavina, Bianchi, and Ferraz (2020). The tests were designed to evaluate the artifact's effectiveness, usability, and quality while considering the managers' perception that the artifact truly contributed to their understanding and evaluation of their partners.

The final evaluation was made by four directors from four different small businesses. The businesses were from the fields of business consulting, agricultural technology, fashion and clothing, and startup acceleration. Initially, a questionnaire with questions about the company's size and interest in starting innovation and open innovation projects was used. The tool was then delivered to the respondent so that they could use it. Finally, a second questionnaire was used to assess the manager's satisfaction with the tool's use. The criteria used

by Giavina, Bianchi, and Ferraz (2020) to evaluate artifacts with the end user were used to assess user satisfaction with the tool. Three weeks later, the manager was contacted again to evaluate three statements about the tool's perceived impact on their assessment of the relationship network.

Between March and April 2021, assessments were conducted via email and WhatsApp. Table 04 contains statements about the company's perception. The concepts "I strongly disagree," "I disagree," "I am indifferent," "I agree," and "I strongly agree" were used to evaluate each.

Table 4

Result of evaluations on the functioning of the artifact applied in companies

Statement about the tool	E1	E2	E3	E4
The tool I used assisted me in learning about the characteristics of suppliers, customers, competitors, and other types of partners in my network of relationships.	I am indifferent	I disagree	I am indifferent	I strongly agree
The tool I used assisted me in determining which suppliers, customers, competitors, or other types of partners to seek in the development of innovation projects planned for the next 12 months.	I agree	I am indifferent	I agree	I strongly agree
If I were in a partnership with a company in my network, the tool would help me determine whether I would have the opportunity to learn and/or use my partner's resources.	I agree	I agree	I agree	I strongly agree

Source: created by the authors (2022).

With the exception of Company 4, a pattern of assessment of the tool's effectiveness was observed: the companies believed that the tool was more useful in determining whether the partners were suitable to start a partnership and if they could take ownership of their resources. A possible analysis of this result could be the tool's operation, in which the company must list its potential partners and its most important resources for a partnership, which may imply that the company already knows what the resources are in the early stages of use, and then the tool would be useless in learning about them.

Each company evaluated the use and quality of the artifact according to Table 05, considering five aspects: very bad (VB), bad (BA), regular (RE), good (GO), and very good (VG):

Table 5

Result of evaluations on the shape of the artifact applied in companies

Aspect	E1	E2	E3	E4
Operation	VG	RE	VG	VG
Layout	VG	GO	VG	RE
Clarity of descriptions and guidelines	GO	RE	VG	VG
Clarity of questions	VG	RE	VG	VG
Presentation of the result	VG	GO	VG	VG
Consistency of the result	VG	RE	VG	VG
Meeting expectations	VG	RE	VG	VG
General Grade	GO	GO	VG	VG

Source: Created by the authors (2022).

The participating companies appear to have given the artifact high marks. The fact that the managers were able to use the tool without any assistance from the researchers, having fully operated the tool and generated the results autonomously, is a good indicator of this result. This success can be attributed to the three pre-assessment tests that comprised the artifact development stage and qualified its usability, writing, and presentation.

Because of the small number of managers interviewed, this analysis is considered preliminary in order to meet the method's steps and allow for a review of the evaluation itself in relation to the proposed instrument.

5 CONCLUSION

The purpose of this study was to create an artifact that could be used to evaluate the SME relationship network and identify potential partners for open innovation projects. In the absence of similar tools that addressed the same class of problem, a new artifact was proposed that would allow a small business manager to analyze their relationships and plan the development of new open innovation projects.

Three tests were conducted for development of the artifact, each with a different methodology and objective, and each yielded between 20 and 30 suggestions for changes. The three tests met their objectives and allowed us to improve the artifact. It is also believed that the order in which these were carried out was ideal: first, an open test with general suggestions (exploratory focus group), then a direct functionality test with the target audience (black box), and finally, a test with researchers who validated whether the concepts used were properly transmitted to the implemented questions (white box). In terms of the preliminary evaluation of the artifact, when resuming contact with the managers who participated in this stage, a pattern

emerged: the managers perceived the tool to be more useful in determining whether the partners would be suitable for starting a partnership and whether they could appropriate their resources. The small number of managers who took part in the preliminary assessment served to demonstrate potential changes that should be made when proposing the form of control and analysis of the designed instrument, as well as in the formulation of analysis questions.

Another limitation considered in the research is related to the configuration stage of the initial class of problems, where other artifacts of the same class of problems that could have served as starting points for this research were not identified; and artifact proposition, where a single artifact project was used for development. However, in terms of the last limitation, it is thought that the content of this tool could be used in a new model in the future if revisions to this artifact make this possible.

As the primary practical contribution of the research, we present an operational artifact that is functional and well received by managers and has the potential to be used as an auxiliary tool in open innovation projects developed by SMEs. This finding has direct practical implications for managers and researchers interested in open innovation studies, specifically open innovation in small businesses, in response to a call from researchers such as Vega-Jurado et al (2015). As Brunswicker and Van De Vrande (2017) point out in their synthesis of the current state of open innovation research in small businesses, open innovation represents a good opportunity for small companies to overcome their limited resources. However, for the same reason, these organizations struggle to manage their relationships and alliances, as well as map their partners (Brunswicker & van de Vrande, 2017). The designed artifact is placed precisely in this context, with the goal of assisting companies in perceiving aspects of their network and deepening their understanding on how to analyze their partners. At the same time, the proposed artifact corresponds to a suggestion made by Dagnino et al (2015), who observe the need to identify and comprehend the conditions under which joining a network can be a strategic resource.

The study also contributes to Gulati, Lavie, and Madhavan (2011)'s theoretical proposal by operationalizing and applying the authors' concepts of richness, reach, and receptivity. Because the application of these concepts is not limited to innovation relationships, but to all types of interorganizational relationships, it is understood that the knowledge generated by this artifact can be adapted for future studies addressing interorganizational relationships.

We consider the identification of the problem and the proposal of an artifact as a relevant formulation for raising new hypotheses and developing subsequent artifacts that adapt or adjust the presented result as a theoretical implication of this study for the field of open innovation in

SMEs (Barrett et al., 2021; Brunswicker & van de Vrande, 2017; Hervas-Oliver et al., 2021; van de Vrande et al., 2009). As a suggestion for future research, we recommend resuming this artifact within the class of problems, conduct a new final evaluation, identify steps to be resumed in the DSR research process, possible adaptations to the artifact, and the possibility of adapting this artifact's theoretical constitution to create new models for practical application in this and other classes of problems. Furthermore, to determine the results of the evaluative test, we recommend the possibility of developing a new test to assess the hypothesis that the tool can influence how companies know their partners after using it for the first time.

AUTHORS’ CONTRIBUTIONS

Contribution	WOLFFENBÜTTEL, V. R.	WEGNER, D.	SILVA, S. B.
Contextualization	X	X	----
Methodology	X	X	----
Software	X	X	----
Validation	X	X	----
Formal analysis	X	X	----
Investigation	X	-----	----
Resources	X	-----	----
Data curation	X	X	----
Original	X	X	----
Revision and editing	X	X	X
Viewing	X	X	X
Supervision	X	X	----
Project management	X	X	----
Obtaining funding	----	X	----

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