

Quantitative Analyses of the Role of Relational Capital on Absorptive Capacity in Knowledge-intensive SME's

Graciele Tonial¹, Florinda Matos², Alessandra Cassol³, Márcio Luiz Marietto⁴, Nathalia Berger Werlang⁵

¹ Programa de Mestrado e Doutorado em Administração, Universidade do Oeste de Santa Catarina, Brasil

² Instituto Universitário de Lisboa (ISCTE-IUL), Centro de Estudos sobre a Mudança Socioeconómica e o Território (DINÂMIA'CET), Lisboa, Portugal.

^{3,4} Programa de Mestrado Profissional em Gestão e Estratégia, Universidade Federal Rural do Rio de Janeiro, Brasil

⁵ Programa de Pós-Graduação em Ciência da Informação, Universidade Federal de Santa Catarina, Brasil

graciele.tonial@unoesc.edu.br

florinda.matos@iscte-iul.pt

alessandracassol.adm@gmail.com

marcioluizmarietto@gmail.com

nathalia.werlang@ufsc.br

Abstract: The research aimed to measure the relational capital influence (RC) on absorption capacity in knowledge-intensive companies. The direct relationship between the different components of relational capital and absorption capacity was analysed through a model of structural equations of partial least squares (PLS-SEM), tested in SmartPLS. This method was chosen for the following reasons: the use of SEM-PLS allows testing causal paths between second-order latent variables, and in addition to offering extensive and flexible causal modelling resources, the technique is recommended for more complex models, with constructs composed of a greater number of variables and with a smaller number of data, as observed in this research. The method is also justified because this research is based on a composite measurement model with a reflective design approach, which means there are correlations between indicators and dimensions. The SmartPLS 3.0 Software was used to carry out the global model evaluation and measurement and structural model evaluation steps. These analyses were conducted in a sample of 174 small and medium-sized technology enterprises (SMEs) that are part of different innovation networks in Brazil. This study highlights that the development of relational capital is supported by collaborative relations of cooperation, trust, communication, and resources invested by enterprises established in different networks. The proposed statistical model allowed proving the relationship factors that help strengthen the relations between the network actors that facilitate the transfer of knowledge. This relationship still needs to be investigated, especially for small and medium-sized knowledge-intensive companies in emerging countries like Brazil. The research conclusion supported the research hypothesis and proved that relational capital is an independent variable that directly and positively influences the absorption capacity process. This study, quantitatively combining the external perspective of relational capital and the internal organisational dimension of absorption capacity, provides valuable information about using quantitative methodologies to explore intangible organisational resources to promote innovation.

Keywords: Quantitative analyses; Structural Equation Modelling; Relational Capital; Absorption Capacity; knowledge-intensive SME's.

1. Introduction

Quantitative research is a powerful tool for managers and organisations seeking to understand the relationships between theories and their market dynamics. It is used to support and underpin the definition of organisational strategies (Bryman, 2016). Thus, in this study we propose to measure the influence and direct relationship between the different components of relational capital (RC) and knowledge absorption capacity (ACAP) in knowledge-intensive companies that are part of innovation ecosystems in Southern Brazil. To test these relationships, we utilized the statistical technique of structural equation modelling with partial least squares estimation (PLS-SEM) in the SmartPLS software.

We opted for the use of PLS-SEM because it is a technique capable of estimating complex models with causal relationships between constructs and for its usability in research in social sciences and business administration (Henseler, Hubona & Ray, 2016). Additionally, the technique is appropriate in situations where the theory supporting causal relationships still lacks exploratory studies (Bido & Da Silva, 2019), as is the case with the

relationships proposed in this study. Finally, this type of analysis allows the results to support decision-making in the business environment (Sekaran & Bougie, 2016).

This article brings contributions to the discussion about the influence of RC factors as a knowledge asset that precedes ACAP (García & Bounfour, 2014; Buenechea-Elberdin et al., 2018), being recognized as an intangible resource and a source of connectivity and innovation in a technological-intensive environment (Ordóñez de Pablos & Edvinsson, 2021). It also provides valuable knowledge on the use of quantitative methodologies for exploring intangible organisational resources.

We have highlighted the existence of opportunities for empirical research that analyses the interrelationship between relational capital and knowledge in dynamic sectors, such as technology companies (Peces & Trillo, 2023). The main challenge for studying intangible factors in organisations, such as relational capital, is to understand how to convert the knowledge originating in the organisation's networks of relationships into new capabilities and knowledge resources (Edvinsson, 2013).

Our findings also enrich the discussions on quantitative research, which supports the analysis of direct and complex relationships, such as in the case of knowledge absorption capability (ACAP). They also expand ongoing research on the role of intangible resources and capabilities in creating competitive advantage (Kashosi et al., 2020), thus contributing to the growing literature on the Knowledge-Based View (KBV) (Flatten et al., 2011, Apriliyanti & Alon, 2017).

2. Literature Synthesis and Hypotheses Development

Relational Capital (RC) is an intangible resource and a component of intellectual capital that can explain the value of an organisation's relationships with its environment (Edvinsson & Malone, 1998, Stewart, 1998). The concept of RC that guides this research is based on the understanding that companies are not an isolated system but belong to an interconnected system that depends on their relationships with the external environment (Knight, 1999). Thus, the RC construct is perceived as an intangible resource formed from the relationships that the company has with the external environment, such as its strategic alliances, cooperative systems, and collaborative relationships of trust among suppliers, customers, competitors, and entities such as universities, associations, public and governmental agencies (Knight, 1999; Kianto, Andreeva & Pavlov, 2013; Garcia & Bounfour, 2014; Buenechea-Elberdin, Kianto & Sáenz, 2017).

Establishing interorganisational relationships can potentiate the creation of wealth from other intangible assets, such as research and development (R&D) and human capital (Kianto, Andreeva & Pavlov, 2013). Developing RC generates close interaction between alliance partners and provides an effective channel for organisational learning, knowledge accumulation and sharing, resulting in better performance for companies (Yoo, Sawyerr & Tan 2016 and Liu, Wang & Su 2023).). Furthermore, it reduces knowledge ambiguity, which, in turn, helps companies improve their knowledge acquisition (Ho, Ghauri & Kafouros, 2019).

The Absorptive Capacity is analysed from the epistemological perspective of the Resource-Based View (RBV) theory proposed by Barney (1991) which discusses the specific resources of a firm for finding competitive advantages. Defined by Cohen and Levinthal (1990) as the ability of a firm to recognize the value of new external information, assimilate it, and apply it for commercial purposes, it is essential for its innovative capabilities. The concept was revisited and expanded by authors Zahra and George (2002) who defined ACAP as a set of organisational routines and processes through which firms acquire, assimilate, transform, and apply knowledge with the purpose of producing a dynamic and sustainable capacity.

The relationship between the constructs of Relational Capital (RC) and Absorptive Capacity (ACAP) have been the focus of different research, such as those conducted by Lu and Wang (2012), García and Bounfour (2014), Ho and Wang (2015), Yoo, Sawyerr and Tan (2016), Terstriep and Lüthje (2018), and Ho, Ghauri and Kafouros (2019). These studies consider the Knowledge Absorption (ACAP) process as a dependent variable of RC.

This research aims to validate the research hypothesis and advance the understanding of Relational Capital as an intangible resource through external relationships capable of directly and positively influencing the process of acquiring, assimilating, transforming, and applying knowledge obtained in the interorganisational environment of companies. Based on the theoretical context presented, the hypothesis of this research is established: **H1 - Relational Capital positively influences Absorptive Capacity.**

3. Methods

3.1 Research Settings

Our research used quantitative data collection in Brazilian technology-based companies (TBCs). These companies participate in different innovation ecosystems, public or private, called technology clusters, parks and/or technological poles, incubators and/or associations of technology companies. Researching TBCs is justified because their dynamics of operation and activities characterize them as knowledge-intensive companies (Tseng, Pai & Hung, 2011; Peces & Trillo, 2023). This intensity of knowledge in their systems and management practices, such as in their activities, processes, products, people, and markets of operation, makes knowledge the main strategic resource capable of establishing sustainable competitive advantage (Neves et al., 2014).

Emerging markets, such as Brazil, are countries with characteristics of developed markets of industrialized countries but which do not meet the necessary conditions to be classified as developed countries (Tajpour et al., 2022). The overall nature of technology companies in Brazil is based on the management, application, analysis, and evaluation of internal and external information to generate knowledge and innovations. However, this can only be achieved if these companies can institutionalize the knowledge absorption process within them. Knowing that most technology companies operate in innovation ecosystems (technology parks, incubators, associations, etc.), relational capital becomes an essential element for acquiring knowledge from the external environment (see Ho, Ghauri, and Kafouros, 2019).

3.2 Sample and Data Collection

Our research targets managers who work in companies with more than 20 employees and hold strategic level positions (CEOs and directors) or managerial positions (HR or innovation managers). We used Dillman's (2007) principles to design and direct our data collection approach. Our efforts included the following steps. First, we developed research questions to ensure that wording and order did not create bias in the data. Additionally, we provided explicit instructions (e.g., answer the survey based on the current situation of your company) to reduce potential social desirability bias. Second, to elicit responses, our email to the interviewees communicated the research context and study methodology in simple and transparent language. Finally, we ran a survey built on the Google Forms tool that started with the disclosure of the interviewee's participation consent and the assurance of respondent data privacy. In other words, all interviewee data was kept confidential. To ensure anonymity, all reported results were statistically aggregated.

We sent the survey to 708 Brazilian TBCs located in ecosystems of three states (Santa Catarina, Paraná, and Rio Grande do Sul), obtaining 174 responses with a response rate of 24.6%. The sample complies with the precepts of Hair et al. (2009), who suggest as a general rule that, to perform data analysis in Structural Equation Modeling (SEM), it is necessary to have at least five times more observations than the number of variables to be analysed. In this case, the minimum number of valid questionnaires would be 125, a which was exceeded.

The companies in the sample operated in different technology sectors, mostly in software and IT (52.5%), and in segments such as artificial intelligence, nanotechnology, biotechnology, agribusiness, education, and industrial automation. The average age of the companies was 9.29 years (SD = 10.62), with an average of 30.86 (SD = 77.03) full-time employees. These data represent the diversity of companies that composed the sample, which enriches the research results.

3.3 Measurement and Validation of Constructs

We employed previously validated measures for all variables, Flatten et al. (2011) and Flatten, Greve, and Brettel (2011). The research instrument began with an English language questionnaire based on previous research. Then, we translated the questionnaire into Portuguese, to avoid cultural bias and ensure conceptual equivalence. We recruited 10 subject matter experts (i.e., scholars of innovation management and executives residing in Brazil) for a pilot study. We asked them to evaluate the survey items to ensure validity. This approach ensured that the survey items were a procedurally validated accurate representation.

The questionnaire was divided into three blocks, containing 25 questions. The first block consisted of 5 questions, called characterization and control variables, such as time of activity in the market, number of employees, R&D investments in the last three years, and whether they actively participated in associations, business conglomerates, and/or other forms of interorganisational cooperation, aimed at identifying and

characterizing the sample. The second block included 5 questions capable of measuring relational capital, and the variables were derived from the studies conducted by Andreeva and Garanina (2016), Buenechea-Elberdin, Kianto, and Sáenz (2017), and Yoo Sawyerr and Tan (2016). The third block had 15 questions that measured absorptive capacity and was adapted from the study by Flatten, Greve, and Brettel (2011).

To measure the variables that make up the measurement model (RC and ACAP), we adopted the Likert scale (1 “totally disagree” to 5 “totally agree”), primarily because it is widely used by research in the area of social sciences, see Rhemtulla et al. (2012). Also due to the significant number of verification items proposed in the established and validated model Flatten et al. (2011) be composed of multiple items.

It is noteworthy that the scores of all items in the questionnaire were combined to generate a composite score, which logically measures a unidimensional trait in its entirety, as recommended by Joshi et al. (2015). The variables are of a scalar nature of the continuous type and the questions chosen are considered empirically important, making it possible to measure the opinion of managers on certain situations that classify the constructs. The results themselves constitute a relevant and proven empirical verification, through the results of the statistical tests.

Table 1: Research variables

Construct	Variables	Authors
Relational Capital	Does our company have a good relationship with its stakeholders, such as companies in a common conglomerate, competitors, suppliers, customers, universities, consultants, or government institutions?	Andreeva and Garanina (2016), Buenechea-Elberdin, Kianto and Saenz (2017) and Yoo Sawyerr and Tan (2016)
	Does our company collaborate with its stakeholders to achieve specific sector goals?	
	Does our company actively cooperate among companies in the same sector and with its stakeholders?	
	Does our company communicate frequently with its stakeholders to share information and knowledge about the sector?	
	Does our company invest resources to develop a successful alliance (collaborative network)?	
Absorptive – Acquisition Capacity	Does our company seek information through joint projects with companies and research institutions beyond our sector?	Flatten, Greve and Brettel (2011), Flatten <i>et al.</i> (2011)
	Is the search for relevant information about our sector a daily activity in our company?	
	Does our company's management encourage employees to use sources of information about our sector?	
	Does our company's management expect employees to seek information from different sectors?	
Absorptive – Assimilation Capacity	In our company, are new information and ideas communicated between different areas (teams/sectors/units/departments)?	
	Does the management of our company support collaboration between different areas (departments) to solve problems?	
	In our company, is there a fast flow of information, so if one unit of the company obtains important information, it communicates that information quickly to all different areas?	
	In our company, are there regular meetings to exchange information, seek solutions, and share achieved results?	
Absorptive – Transformation Capacity	Do our employees have the ability to structure and use knowledge collected from external sources?	
	Are our employees accustomed to absorbing new knowledge, as well as making it available and preparing it for other purposes?	
	Do our employees associate existing knowledge with new ideas and/or insights?	
	Are our employees able to apply new knowledge to their daily work routines and practices?	

Construct	Variables	Authors
Absorptive – Application Capacity	Does the management of our company support the development of prototypes (product/service testing) based on newly acquired knowledge?	
	Does our company regularly reconsider technologies and adapt them according to newly acquired knowledge?	
	Does our company have the ability to work more effectively by adopting new technologies?	

Source: Elaborated based on the studies of Andreeva and Garanina (2016), Buenechea-Elberdin, Kianto and Sáenz (2017), Yoo Sawyerr and Tan (2016), Flatten et al. (2011), and Flatten, Greve and Brettel (2011)

3.4 Construct and Method Validity

For data analysis, we organized, coded, and tabulated the data in Excel spreadsheets for statistical analysis and interpretation, following the guidelines of Hair et al. (2009). Frequency and percentage checks for numerical data and normal distribution of variables were performed using the Statistical Package for Social Science (SPSS) software version 24.0.

We also used structural equation modelling (SEM) with partial least squares estimation (PLS-SEM) supported by SmartPLS software, version 2.0. First, we evaluated the measurement model, where we observed convergent validity (average variance extracted - AVE), internal consistency (composite reliability and Cronbach's alpha), and discriminant validity (Fornell-Larcker criterion). The second step was the evaluation of the structural model, where we observed the significance of correlations and regressions through the Student's t-test.

4. Descriptive Analyses using PLS-SEM

The evaluation of the measurement model aims to assess and ensure the reliability and validity of each analysis construct, specifying the relationships between a construct and its indicators and observing if they are indeed representative. For this research, we followed the criteria proposed by Hair et al. (2014), Ringle, Da Silva and Bido (2014), Henseler, Hubona and Ray (2016), and Bido and Da Silva (2019).

The constructs were evaluated as reflective indicators, and the model assessment followed the criteria and sequence suggested by Ringle, Da Silva, and Bido (2014). The first aspect observed was the convergent validity and reliability of the constructs (Hair et al., 2014), through the calculation of the Average Variance Extracted (AVE > 0.50), Composite Reliability (CR > 0.7), and Cronbach's Alpha (CA > 0.6 and 0.7), and the analysis of the Fornell-Larcker Criterion (Henseler, Hubona, & Ray, 2016), presented in Table 2.

Table 2: Correlation matrix between LV (n=174) Fornell-Larcker Criterion

(a) 1 st Order Variables	Acquisition	Assimilation	Transformation	Application	RC
Acquisition	0.772				
Assimilation	0.551	0.805			
Transformation	0.482	0.591	0.877		
Application	0.516	0.544	0.593	0.858	
Relational Capital (RC)	0.484	0.415	0.419	0.370	0.809
Average Variance Extracted (AVE)	0.595	0.648	0.769	0.737	0.654
Composite Reliability (CR)	0.854	0.880	0.930	0.894	0.904
Cronbach's alpha (CA)	0.771	0.817	0.900	0.821	0.867
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(b) LV of the Structural Model	ACAP	RC			
Absorption capacity (ACAP)	0.811				

(a) 1 st Order Variables	Acquisition	Assimilation	Transformation	Application	RC
Relational Capital (RC)	0.521	0.809			
Average Variance Extracted (AVE)	0.658	0.654			
Composite Reliability (CR)	0.885	0.904			
Cronbach's alpha (CA)	0.912	0.867			

The values presented satisfactory results, as the Cronbach's Alpha, for both the variables and constructs, showed values above 0.70, as recommended by Hair et al. (2014). The assessment of Composite Reliability (CR) for each construct also showed adequate results, that is, the values were above 0.80, indicating the reliability of the model. We confirmed the convergent validity of the variables, as the values of Average Variance Extracted (AVE) were above 0.5, according to the criteria of Hair et al. (2014) and Henseler, Ringle, and Sinkovics (2009). The results shown in Table 2 present satisfactory values for the assumptions, thus it is assumed that the model converges to a satisfactory result.

The Discriminant Validity (Fornell-Larcker criterion) was considered adequate, as the results of the square root of the AVE of each construct were higher than the correlations with other constructs. The correlations among the variables were smaller than the square root of the AVE, thus meeting the assumptions, as recommended by Hair et al. (2014).

The second step of the analysis was the evaluation and analysis of the structural model. First, we assessed the effect of the Pearson coefficient, as recommended by the Cohen (1988), which considers $R^2 = 2\%$ as a small effect, $R^2 = 13\%$ as a medium effect, and $R^2 = 26\%$ as a large effect. The results showed values of 27.2%, which are higher than 26%, indicating a large effect and guaranteeing the quality of the proposed model, as presented in Table 3.

Table 3: Pearson coefficient effect (R^2)

	(R^2)	%	Cohen (1998)
Relational Capital positively influences absorption capacity	0.272	27.2	Large effect

Finally, we evaluated the structural model by observing the significance of correlations and regressions through the Student's t-test. The Relational Capital (RC) was analysed as an exogenous and independent construct.

The tests for hypothesis (H1) confirmed that RC is positively related and influences ACAP, and this hypothesis relationship presented a structural coefficient (β) value of 0.521. This means that RC positively influences ACAP by 52%, with a standard error of 0.053 and very high significance ($p < 0.00$). The T-test value was 10.249, which means that if there is a variation in the company's Relational Capital, it affects the Absorptive Capacity positively. The effect size (f^2) was also evaluated based on Cohen's (1988) proposal, and this hypothesis had a large (f^2) value of 0.373.

Table 4: Hypothesis analysis

Hypothesis	Relationship	Structural Coefficient (β)	Standard error	t-Value (T Test)	Effect of relationships (f^2)	P-Value	Situation
H1+	Relational C -> ACAP	0.521	0.053	10.249	0.373	0.000	Supported

The statistical tests conducted on the structural and measurement models allowed us to conclude that H1 was supported. The findings indicate that the higher the levels of RC in companies participating in innovation ecosystems, the greater the chances that these companies will access and apply the knowledge available in the external environment.

In this sense, it is possible to infer that the sources of knowledge generated through this capital precede the Knowledge Absorption Capacity (ACAP). That is, the greater the collaboration, cooperation, and communication

relationships established by companies with their stakeholders (partner companies in a common conglomerate, suppliers, customers, universities, consultants or government institutions), the greater the sources of knowledge accessed, thus driving the ACAP process that resides in practical actions of acquiring knowledge from the external environment, and assimilating, transforming, and applying this knowledge for commercial purposes (Zahra & George, 2002).

This hypothesis confirms that strong RC influences and strengthens the process of ACAP, the beta value of 52% confirms the strength of this hypothesis's relationship. Similar evidence was found in the research of Lu and Wang (2012) in the context of industries.

5. Detecting Causal Relationships using Structural Equations

The statistical analyses performed through structural equation modelling (SEM) with partial least squares estimation (PLS-SEM) allowed us to confirm and support the proposal of this research to analyse the positive relationship and influence of Relational Capital on ACAP. The study findings also allowed us to infer about the importance of relational capital on absorptive capacity in the context of the investigated organisations. We still highlight that this relationship can be strengthened based on the trust that exists between organisations and their stakeholders, through the strong collaboration and cooperation strategies in the technology sector, through the established communication process in the sharing of information and knowledge, and through the use of various resources in forming alliances.

The research expands and strengthens the proposal that statistical methods are useful for understanding how relationships between RC factors can be responsible for reducing the ambiguity of knowledge obtained in the interorganisational environment, which in turn influences and improves the ACAP process, contributing to strategic management processes and decisions. Thus, it can be assumed that collaborative environments, such as innovation ecosystems, enable interaction, cooperation, and collaboration among companies, which, by developing knowledge capabilities, can take advantage of these resources to remain competitive in the market.

6. Main Findings and Limitations

This research contributes to advancing quantitative research in the knowledge management field by filling the gaps that highlight the antecedent factors and the processes of knowledge absorption. The statistical relationships between the RC and ACAP constructs were confirmed, considering the context of technology companies in emerging countries, which remain underexplored factors in the literature.

We also consider that it is relevant for company managers operating in an emerging economy and a dynamic, complex, and highly technological mobility environment, such as the technology sector, to explore the intangible resources of RC as a strategy to mitigate barriers to innovation. Additionally, this research presents statistical data that demonstrate the importance of companies in recognizing the value of knowledge from external sources for acquiring, assimilating, transforming, and applying this knowledge in innovations.

As limiting factors, we may mention the number of respondent companies from each ecosystem, which made it impossible to conduct a comparative analysis between companies or ecosystems, or even the position of companies in the network, for example. We also highlight a limitation regarding the cross-sectional approach in the data collection stage, which limits the analysis of different phenomena occurring in organisational environments after data collection, something that could interfere with results and analysis.

Considering the limitations, we propose that future studies use other software and/or statistical analysis models to deepen research on RC, conducting studies to understand the relationships between variables from different perspectives. We also consider it pertinent for new research to analyse and compare low-tech clusters with high-tech ones, expanding research on the importance of Relational Capital and its impact on firm capabilities.

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