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Collaboration for Innovation and Sustainable Performance: Evidence of Relationship in Electro-Electronic Industry

Marcos Roberto Kuhl[†]
State University of Centro-Oeste – UNICENTRO

João Carlos da Cunha[Ω]
Positivo University – UP

Marlete Beatriz Maçaneiro[¥]
State University of Centro-Oeste – UNICENTRO

Sieglinde Kindl da Cunha[±]
Positivo University – UP

ABSTRACT

This study aimed to identify how collaboration for innovation relates to the sustainable performance of the electronics industry in Brazil. We used a quantitative approach, collecting data by means of a cross-sectional survey in a sample of 112 companies. The main result indicates that the relationship between collaboration and sustainable performance is positive and significant, but of low intensity, confirming the indication from the literature. The same is noticed in checking the relationship between the collaboration and the three dimensions of sustainable performance, although no statistically significant difference was found between the degree of correlation and the three dimensions. Intervening factors such as size, age, internationalization and capital structure were also considered in verifying the relationship between collaboration for innovation and sustainable performance.

Keywords: Innovation. Collaboration for innovation. Sustainability. Sustainable performance. Electro-electronic industry.

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Author for correspondence:

[†]. Doctor in Administration
Link: State University of Centro-Oeste - UNICENTRO
Address: Rua Padre Salvatore Renna, 875 – Santa Cruz – Guarapuava – Paraná
CEP 85015-430
E-mail: marcosrobertokuhl@yahoo.com.br
Phone: (42) 3621-1000

[Ω] Doctor in Administration
Link: Positivo University - UP
Address: Rua Prof. Pedro Viriato Parigot de Souza, 5300 - Campo Comprido, Curitiba – PR - CEP: 81280-330
E-mail: jccunhaisat@gmail.com
Phone: (41) 3317-3279

[¥] Doctor in Administration
Link: State University of Centro-Oeste - UNICENTRO
Address: Rua Padre Salvatore Renna, 875 – Santa Cruz – Guarapuava – Paraná
CEP 85015-430
E-mail: marlete.beatriz@yahoo.com.br
Phone: (42) 3621-1000:

± Doctor in Economic Sciences
Link: Positivo University - UP
Adress: Rua Prof. Pedro Viriato Parigot de Souza, 5300 - Campo Comprido, Curitiba – PR - CEP: 81280-330.
E-mail: skcunha21@gmail.com
Phone: (41) 3317-3001

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1 INTRODUCTION

The constant search for innovation in organizations has as its main purpose to maintain the level competitiveness of these companies on the market or as highlighted by Coral and Geisler (2008), achieving a sustainable competitive advantage. "Innovation is a key element of corporate competitiveness in the 21st century, and has therefore attracted special attention of management researchers and practitioners" (MELLO *et al.*, 2008, p. 58). "It is widely acknowledged that technological change and innovation are major drivers of economic growth and lie at the very heart of the competitive process", (CAINELLI; EVANGELISTA; SAVON, 2005, p. 435). This was already argued by Schumpter (1997) in the beginning of the 21st century. Thus, "innovation is critical for the sustained development and prosperity of organizations", (GOMES *et al.*, 2011, p. 3) as well as obtaining a competitive advantage, in which the economic approach is the center of activities (DAROIT; NASCIMENTO, 2004).

On the other hand, in recent years, much has been discussed about the environmental and social impacts caused by economic activity, so that "companies are considered by many as being the main actors that create social and environmental problems as well as being the source of the lack of sustainability in society" (SCHALTEGGER; WAGNER, 2011, p. 222). Bessant and Tidd (2009) emphasize that innovation is singled out as having a significant contribution to the degradation of the environment, basically for constituting an important portion of economic growth and consumption.

However, according to Elkington (2001), the companies are the only organizations with resources, technology, reach and motivation to "achieve" sustainability. Porter and van der Linde (1995) and Bessant and Tidd (2009) point out that innovation can also become an important part of the solution to environmental issues, especially by the insertion of products and technologies with environmentally correct bias. To the same end, Daroit and Nascimento (2000, emphasized that the quest for higher environmental quality enables the generation of innovations that improve production efficiency, contributing to the competitiveness of companies. This is one of the main challenges of organizations: Balancing sustainability with economic development (HAHN; SCHEERMESSER, 2006).

However Nidumolu, Prahalad and Rangaswami (2009) and Bessant and Tidd (2009), claim that few innovations can be developed in the world today, without companies joining

with other companies or organizations. The importance of collaboration for innovation had already been highlighted by Rothwell (1994), in his proposition of the fifth generation characteristics of the innovation process, being one of those characteristics precisely the strong vertical and horizontal links between companies. And the management "the interfaces between the partners in the development of innovation expands business opportunities and improves performance" (GOMES; KRUGLIANSKAS; SCHERER, 2012, p. 2).

Within this context, the relationship between innovation and sustainability, including the inter-organizational collaboration, few studies have been developed, although discussions on innovation and sustainability are found in different disciplines. In a study conducted with the main national and international journals that publish studies related to innovation and sustainability, we found some studies that jointly discuss innovation and sustainability, among which are: Hartman, Hofman and Stafford (1999); Fadeeva (2004); Barbieri (2007); Barbieri *et al.* (2010); Sarkis, Cordeiro and Brust (2010); Murray, Haynes and Hudson (2010); Petzel, Archer and Fei (2010); Bos-Brouwers (2010); Schaltegger and Wagner (2011); Scandelari (2011); Damasceno *et al.* (2011); Scandelari and Cunha (2013). The survey was conducted basically in the field of applied social sciences, considering in particular, publications carried out between 2007 and 2011, but including some outside this time limit.

This is not an exhaustive list, but a survey that reinforces the importance of the subject and its scope, as well as the various possibilities of advancement in the studies to be developed. In the texts, a significant importance for the relationship between collaboration for innovation and sustainability is assigned, regardless of any them presenting empirical evidence.

Given this, the objective of this study was to identify how the collaboration for innovation relates to sustainable performance. As specific objectives we defined: to measure the intensity of the relationship between the collaboration for innovation and sustainable performance; to verify whether intervening or control variables (size, age, internationalization, capital control) interfere in that relationship. The study is limited to a sample of companies in the electro-electronics sector in Brazil, as will be described in the methodological aspects.

2 THEORETICAL FRAMEWORK

With regard to collaboration for innovation, according to Murray, Haynes and Hudson (2010), terms such as partnership, cooperation, alliance and coalition are used to describe the phenomenon of the junction of different parts to achieve and objective within a collaboration

agreement. Balestrin, Verschoore and Reyes Junior (2010) also used terms such as networks, cooperation, alliances, partnerships, collaboration and consortium as an expression of the same phenomenon. Cropper, Ebers, Huxham and Ring (2010) present some terms commonly used for inter-organizational relationship (alliance, consortium, network, association, constellation, zone, cluster, cooperation, coalition, federation, relationship, collaboration, joint venture, partnership). Thus, these terms can be found in the literature, sometimes considered as synonyms, to express collaboration. The term is most used in literature that deals with innovation, but in some cases is also called interaction, for example, Romijn and Albaladejo (2002), Eurostat (2004) and OCDE (organization for economic co-operation and development) (2005). Collaboration however is a form of inter-organizational relationship and considered in this study as the most suitable to represent this phenomenon.

Regardless of how collaboration is referred to, it deals with the formal relationship between organizations, in order to develop innovations or innovation projects. Informal relationships are more related to sources of information, while the formal relations are more related to collaborative interactions. According to the OCDE (2005, p. 51), "systematic approaches often underscore interactions as the most vital area for the promotion of innovation activity." The OCDE (2005, p. 95) also points out that "interactions can generate knowledge and technology for any type of innovation (product, process, or organizational marketing)."

The IBGE (Brazilian Geography and Statistics Office) (2010, p. 24) considers the collaboration for innovation as "the active participation of the company in joint projects of R&D and other innovation projects with another organization (company or institution), which does not necessarily imply that the involved parties get immediate business benefits". Following on, it also states that "the simple hiring of services of another organization, without their active collaboration, is not considered cooperation" (IBGE, 2010, p. 24). The hiring of services of another organization, without their active collaboration in the process of innovation, can be considered a source of information or a simple recruitment.

Despite some differences in how each of the forms of collaboration is performed, all are configured by the merging of two or more organizations seeking to achieve a goal, which possibly may fail to do so individually. Thus, even if etymologically or in terms of practical viability they are different, for this study, all will be considered similar.

Johannessen and Olsen (2010) believe that new structures of collaboration are one of the mechanisms that initiate, sustain or reinforce the process of social change and also

improve the innovation. Thus, Nidumolu, Prahalad and Rangaswami (2009), claim that few innovations can be developed in the world today without companies joining with other companies or organizations. For Malachias and Meireles (2009), collaboration is one of the variables that contribute in measuring the innovative profile of companies, so that statistically significant relationship with innovative profile was presented. Similarly, to Mello *et al.* (2008), the relationship with other organizations is one of the factors of innovative capacity.

Collaboration is so important for the innovation that countries such as the United Kingdom have public policies that try to encourage the allocation of funds through the collaboration between companies (Tomlinson, 2010). Tomlinson (2010) still points out that literature and empirical evidence tends to support the notion that the collaboration between companies has a positive impact on innovation. Seen in these terms, Chesbrough (2011) highlights that companies such Intel, Microsoft, Cisco, Genentech, Amgen, Gezyme, although being considered to be highly innovative, develop little basic research internally, but innovate from the discoveries of other organizations.

Some studies already include collaboration for some time in its databases, such as the Community Innovation Survey (CIS) and the Innobarometer survey, in Europe, and the Research of Technological Innovation (PINTEC) in Brazil. However, the focus is limited to the verification of the importance attributed by the surveyed companies to organizations to whom they collaborate with.

The data available in the CIS (consortium of social information) are considered entirely in some studies, for example, Howells and Tether (2004) and Cainelli and by Evangelista and Savona (2005). In other researches however, authors choose to consider only some of the countries (see Evangelista and Savona (2003), who consider Italy; Tether (2002), considers the United Kingdom; CSO (2009), considers Ireland; and Hipp and Grupp (2005), who consider Germany). The Innobarometer data are also considered in some studies, including those by Howells and Tether (2004) and Tether (2005).

The data collection by CIS, by the Innobarometer and by PINTEC, conducted through questionnaires, is based on these data (sources of innovation), as previously highlighted. However, in all these studies, the reasons that lead companies to seek these organizations to collaborate are not empirically explored. Thus, this is one of the points at which this study innovates; that is, it explores empirically the reasons that lead to collaboration for innovation, henceforth referred to only as collaboration.

Within the collaborative approach to innovation, some aspects are important, among which the reasons that lead to collaboration stand out, who to collaborate with and the objective of collaboration. The latter, in the context of this study, is innovation. The first two will be addressed in more detail in the following.

The reasons to cooperate found in literature are summarized in: risk reduction associated with the innovation process (TETHER, 2002; TIDD; BESSANT; PAVITT, 2008); reducing the cost and time associated with the process of innovation (FADEEVA, 2004; TIDD; BESSANT; PAVITT, 2008); access to technological, financial resources amongst other resources (TETHER, 2002; OCDE, 2005; BOS-BROUWERS, 2010); access to knowledge, information and learning (TETHER, 2002; ROMJIN; ALBALADEJO, 2002; OCDE, 2005; TIDD; BESSANT; PAVITT, 2008; BOS-BROUWERS, 2010); achieving economies of scale (TIDD; BESSANT; PAVITT, 2008); pressure from stakeholders (MURRAY; HAYNES; HUDSON, 2010).

The reviewed literature also indicated who to collaborate with (sources of collaboration), as summarized: suppliers, customers or consumers, competitors or other companies from the same segment and consultancies (TETHER, 2002; ROMIJN; ALBALADEJO, 2002; HOWELLS; TETHER, 2004; EUROSTAT, 2004; OCDE, 2005; MANSURY; LOVE, 2008; CSO, 2009; IBGE, 2010); universities or other educational institutions, research institutes and public or private R&D (TETHER, 2002; ROMIJN; ALBALADEJO, 2002; HOWELLS; TETHER, 2004; EUROSTAT, 2004; OCDE, 2005; CSO, 2009; IBGE, 2010); other companies in the same corporate group (ROMIJN; ALBALADEJO, 2002; EUROSTAT, 2004; OCDE, 2005; CSO, 2009; IBGE, 2010); professional training centers and technical assistance (ROMIJN; ALBALADEJO, 2002; IBGE, 2010).

In the context of sustainability and sustainable performance, Jabareeen (2008, p. 181), highlights that "the term sustainability belongs, originally, to the field of ecology, referring to the potential of an ecosystem subsisting over time, with almost no change". Thus, "sustainability is seen as a characteristic of a process or state that can be kept indefinitely", (JABAREEN, 2008, p. 181). The natural systems or subsystems may be considered naturally sustainable. However, unnatural or artificial systems or subsystems do not have this characteristic and, consequently, can enter into a non-sustainable situation until its collapse. Sustainability is extremely important for these systems because its cycle is often disregarded for not being of easy recognition.

Although only recently the term sustainability has been added to the popular vocabulary, the concept has its roots in ancient times, as can be observed in the philosophy of some religions in early Chinese culture, in the Hebrew Scriptures and the customs of the Native Americans, among many other examples around the world (GOMIS et al., 2011). Yet, "sustainability is a complex and confusing concept" (FABER; JORNA; ENGELEN, 2005, p. 1). "What in fact predominates, in spite of so many theoretical efforts, is the lack of consensus on the meaning attributed to sustainability" (CLARO; CLARO; AMÂNCIO, 2008, p. 290). Faber, Jorna and Engelen (2005) claimed the existence, at the time of their study, about fifty definitions of sustainability, but, despite the different views, all discuss the same issue. These arguments are maybe justifiable because there is a certain degree of imprecision about what the word sustainable could mean (BARBIERI, 2007), or due to the exacerbated promotion of interdisciplinarity, so accepted in relation to sustainable development (MUNCK; SOUZA, 2011).

According to Barbieri *et al.* (2010), the expression "sustainable development" began to popularize from the UNCED (United Nations conference on environment and development) held in Rio de Janeiro in 1992, when according to Blackburn (2007), it was explained in 27 principles. But it is "important to note that a consensus has not yet been reached on the precise definition of this concept, there being more than one definition" (CANELAS, 2005, p. 5). That is because, according to Canelas (2005), development was considered synonymous with economic growth, and economic growth was considered to be the origin of the social and environmental problems (BARBIERI *et al.*, 2005; BESSANT; TIDD, 2009). Thus, the idea is that development is understood as a process of promoting improvements in living conditions of the population, respecting the environment (BARBIERI, 2007).

Perhaps this lack of consensus is justified because some studies dealing with sustainability do not define it or, when otherwise, use definitions that characterize sustainable performance. Blackburn (2007) deals with sustainability, but defines only the sustainable performance, seeking this definition in the report of the Brundtland Commission, being that the report does not define sustainability, though it does sustainable performance.

Currently, the term sustainable development covers different interests and multiple compositions. However, all "definitions carry the notion that sustainable development is composed of three dimensions: economic, social and environmental or ecological" (CLARO; CLARO; AMÂNCIO, 2008, p. 292). This composition is not new, from the perspective of the existence of sustainability as a global paradigm. The three dimensions of sustainability are

those originally proposed by Elkington (2001) and the most considered in several studies that address the issue. However, other dimensions not covered in this study, are addressed or quoted in some others, such as the geographic dimension (spatial) (SACHS, 1993; SCANDELARI, 2011) and cultural dimension (SACHS, 1993; NURSE, 2006; SCANDELARI, 2011).

According to Neely (1999), one of the great difficulties in measuring performance is the large number of measures that can be used and, therefore, working to rationalize the alternatives and summarize their advantages and disadvantages is undoubtedly beneficial. For Rabelo and Lima (2007, p. 62), "concern about sustainability indicators is emphasized around the world, with about 559 sustainability indicators initiatives. In Brazil, the Brazilian Institute of Geography and Statistics (IBGE) works with 59 sustainability indicators. "**There are no definitive indicators of sustainability**, which explains, in a way, the various existing indicator systems." (RABELO; LIMA, 2007, p. 63 – emphasis in original). However the indicators are specified to meet some expectations.

Thus, between alternatives for measuring sustainable performance, in this study we chose to use the model created by Scandelari (2011). The model takes into account the sustainable performance in the economic dimension, from the perspective of comparison of the organization's performance with the performance of its main competitor, expanding this perspective to the other dimensions. This choice is justified in view of the complexity of measuring the performance and the successful use of this model by Scandelari (2011), in which the instrument validation has already been done by experts, by conducting pre-test and carrying out the tests of reliability and internal consistency of the scales used.

The indicators used by Scandelari (2011) are based on texts by Perin (2001) and Perform (2002) and on indicators of sustainable production, proposed by the Lowell Center for Sustainable Production (LCSP) (Greiner, 2001).

3 METHODOLOGICAL ASPECTS

This is an exploratory study, based on a quantitative approach, using the survey strategy with cross section. The study was conducted with electro-electronics companies, of all sizes and from all regions of Brazil, where the data were collected in the period from August to October 2012.

Within the chosen sector, there are companies characterized as being industries of electrical products and industries of electronic products (groups 26 and 27 of the national

classification of economic activities, respectively). According to the Annual industry Research - PIA (IBGE, 2012), there were, in 2009, 4.815 companies from this sector in Brazil with five or more people employed, and according to information only available on the IBGE website referring to PIA/2010, with such information not included in print publication, there were in that year 7.235 companies within the two sectors, regardless of the number of employees.

We obtained contact details for these companies along the listings available on the internet, 733 of which were first contacted by telephone to identify the person who could respond to the questionnaire. In addition to these, over 1000 firms were invited to participate in the survey with only an email being sent to them, with 430 being returned due to post-delivery email error and four requested to be excluded from the list, remaining 566 companies. Of the companies that were contacted initially by phone, 95answered the questionnaire completely and of the companies that were only contacted by e-mail, only 19 answered the questionnaire completely.

The sample was non-probabilistic because the selection did not follow any *a priori* procedure for it to be considered statistically representative of the population (HAIR JR. *et al.*, 2005, p. 246).

The instrument we used for data collection was a structured questionnaire, electronically available with the help of the Qualtrics® system by means of sending the link via email. The questionnaire was evaluated in terms of content validity by three faculty experts and we also performed a pretest with three directors/managers of companies and three university professors with experience in the field

Before performing a data analysis, we conducted a validation and cleansing of data, in the sense of eliminating possible failures and distortions resulting from errors in completing the instrument, verifying for missing values and outliers. In this connection, we performed the analysis of each variable by construct, through the Boxplot chart, detecting only two questionnaires with data considered extremes (outliers). These were excluded from the analysis. There was no missing data (missing values) because all data considered essential were locked in the system, fact that did not allow the respondent to complete the questionnaire without all the answers being filled. One hundred and twelve valid questionnaires remained for analysis.

The analysis of data was based on inferential statistics by Kendall's correlation coefficient, through the determining rate and Fisher's *r* to *z* transform test (SHESKIN, 2000). These analyses were carried out on the basis of the constructs "collaboration for innovation" and "sustainable performance". We used a five-point interval scale, following the pattern used by Scandelari (2011), however, we opted for Kendall's correlation, because according to Hair Jr. *et al.* (2005), these scales (usually used in business management studies, regardless of the number of points), in restricted terms, these are ordinal scales, but treated as if they were interval ones. Due to the controversies on this issue (ordinal x interval scale), we opted for the non-parametric test for correlation analysis, this test is considered more appropriate for ordinal type scales.

The collaboration "construct" is characterized by the relationship between organizations, with active participation of both parties whose aim is to develop and/or implement innovations or innovation projects, such objective would hardly be achieved individually (TETHER, 2002; HOWELLS; TETHER, 2004; OCDE, 2005; NIDUMOLU; PRAHALAD; RANGASWAMI, 2009; IBGE, 2010; MURRAY; HAYNES; HUDSON, 2010). Operationally, collaboration in organizations will be determined by two different perspectives: source and reason for collaboration. The average of the variables of the two constructs (reasons and sources of collaboration) determines the construct "collaboration".

Table 1 presents the variables concerning the reasons and sources of collaboration, as well as the question included in the data collection instrument.

Table 1 – Identification of the Reasons and Sources of Collaboration for Innovation

QUESTION	**Among the reasons listed below, what DEGREE OF IMPORTANCE of each of them in order for your company to have sought to collaborate with other organizations in order to develop and/or implement products or new or significantly improved production or organizational processes?**
REASONS	Reduction of the risk associated with the innovation process.
	Reduction of the cost associated with the innovation process.
	Reduction of time associated with the innovation process.
	Achieve economies of scale.
	Pressure from stakeholders.
	Access to technological resources.

	Access to financial resources.
	Access to knowledge, information and learning.
	Access to other resources.
QUESTION	**Considering the actions taken in the last two years, compared to your main competitor, HOW OFTEN has your company collaborated with organizations listed below in order to develop and/or implement products or new or significantly improved production or organizational processes?**
SOURCES	Suppliers or organizations from supply chain.
	Customers or consumers (except individuals).
	Competitors or other companies in the same segment.
	Consulting for development or implementation of innovation.
	Professional training centers and technical assistance.
	Subsidiaries or other companies within the same corporate group.
	Universities or other institutions of higher education.
	Research institutes and private and public laboratories of R&D.
	Public research institutes or innovation support and private non-profit institutes.

Source: Prepared by the authors.

To measure the construct "collaboration", from the reasons of collaboration and sources of collaboration, we used a five-point scale, within the same standards of the scale used to measure the construct "sustainable performance".

The construct "sustainable performance" is characterized by the capacity of a system or subsystem to meet their current needs without compromising the possibility of meeting their future needs. In principle, sustainable development seeks to ensure that current actions do not limit the range of economic, social and environmental options available to future generations. A central aspect of sustainable performance is the balance between the three dimensions, through environmental protection, social development and economic prosperity (BLACKBURN, 2007; BARBIERI, 2007; CLARO; CLARO; AMÂNCIO, 2008; DAMASCENO *et al.*, 2011; MUNCK; SOUZA, 2011). Operationally, sustainable performance will be determined by the average of the three dimensions of sustainability (economic, social and environmental), measured in accordance with the issues and with the scales used by Scandelari (2011).

Table 2 presents the variables relating to the three dimensions of sustainable performance, as well as the question included in the data collection instrument.

Table 2 – Measurement Variables of Sustainable Performance

QUESTION	**Evaluate your company's actions over the past two years, regarding ECONOMIC PERFORMANCE, comparing their INTENSITY relative to your main competitor.**
ECONOMIC PERFORMANCE	Practices which aim to minimize the risk of losses arising from environmental responsibility, of health and safety.
	Practices which aim to avoid complaints and returns on the part of customers.
	Market share growth rate.
	Revenue growth rate.
	Profitability (operating profit in relation to sales).
	Overall performance.
QUESTION	**Evaluate your company's actions over the past two years, regarding SOCIAL PERFORMANCE, comparing their INTENSITY relative to your main competitor.**
SOCIAL PERFORMANCE	Prioritizes the generation of opportunities for the local/regional community.
	Adopts inclusion policies for disabled, blacks, women, and other groups considered minorities.
	Carrying out investments for the improvement of life quality of the local community.
	t seeks to involve stakeholders (society, government, employees and other stakeholders) in relevant decisions of the company.
	Offers training and training courses for all employees.
	Seeks to reduce the turnover rate of the workforce.
	Implements practices that lead to better working conditions, in order to increase the well-being and satisfaction of employees with work.
	Seeks suggestions from employees regarding the improvement of products quality, processes and the performance of health, security and environment systems.
QUESTION	**Evaluate your company's actions over the past two years, regarding ENVIRONMENTAL PERFORMANCE, comparing their INTENSITY relative to your main competitor.**
ENVIRONMENTAL PERFORMANCE	Seeks to reduce water consumption per product produced.
	Seeks to reduce the material consumption per product produced.
	Seeks to reduce energy consumption per product produced.

	Replaces conventional energy sources for energy from renewable sources (clean).
	Seeks to decrease the use of packaging materials.
	Seeks to eliminate the use of toxic chemicals, persistent and bio-accumulative.
	Develops actions to reduce the amount of waste generated in the production process.
	Diffuses the practice of recycling in their operations.
	Develops products to facilitate its dismantling, reuse and recycling of materials (reverse logistics).
	Uses recyclable/biodegradable packaging.
	Offers products with take-back policy (that return to the company after use).
	Adopts practices that aim to reduce the emission of gases (greenhouse and acids).
	Develops efficient products compared to energy consumption, and economy in the usage phase.

Source: based on Scandelari (2011, p. 152-154).

In all cases, we verified for internal consistency, or reliability, of the range through the Cronbach's alpha, which is "the most common measure of reliability." (FIELD, 2009, p. 594). The resulting values were above 0.60, given the parameters mentioned by Hair Jr. *et al.* (2005), by Malhotra (2006) and by Field (2009).

Before going into the data analysis, it is necessary to emphasize that the results and conclusions and assumptions from those results are based on the perception of respondents, so they are reflections of those perceptions.

4 DATA ANALYSIS

We conducted the data analysis by evaluation of Kendall's correlation coefficient, which provides a numerical synthesis of the direction and intensity of the relationship between two variables. That is, it allows evaluating the association between variables, with high coefficients indicating high covariance and a strong relationship. The size of the coefficient (effect size) is evaluated according to the proposed framework by Kühl (2013, p. 174).

In addition to the correlation coefficient, we also calculated the levels of practical significance, by means of determining rates. "The correlation coefficient squared (known as the determining coefficient, R^2) is a measure of the amount of variation in a variable that is explained by the other" (FIELD, 2009, p. 143). The result of this calculation must be converted to percentage and will explain this variation. Thus, the correlation shows whether

they relate, the direction of the relationship (positive or negative) and the strength between the variables.

The determination of the "sustainable performance" construct was done by the average of the constructs "social performance", "environmental performance" and "economic performance" and the construct "collaboration" was determined by the average of the constructs "sources of collaboration" and "reasons of collaboration", as previously observed.

Thus, the correlation coefficient between the constructs and the significance level of the relationship are presented in Table 1.

Table 1 – Result of Correlation Analysis

CONSTRUCTS	MEAN	Kendall's correlation			INTERPRETATION
		τ	Sig.	R^2	
Collaboration Sustainable Performance	3.41 3.54	0.377[A]	0.000	14%	Weak positive correlation
Collaboration Economic Performance	3.41 3.63	0.307[A]	0.000	9%	Weak positive correlation
Collaboration Social Performance	3.41 3.50	0.337[A]	0.000	11%	Weak positive correlation
Collaboration Environmental Performance	3.41 3.49	0.280[A]	0.000	8%	Weak positive correlation

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

On the basis of these results, we can identify that the relationship between collaboration and sustainable performance , including in its three dimensions individually, it is fairly close in terms of intensity, and we also considered the determining rate (R^2). This result confirms what was appointed by Hartman, Hofman and Stafford (1999), Fadeeva (2004), Petzel, Archer and Fei (2010), Bos-Brouwers (2010), Murray, Haynes and Hudson (2010) and especially by Sarkis, Cordeiro and Brust (2010). It is worth highlighting that the social dimension is slightly higher than the other two, while the environmental dimension is slightly lower. However Fisher's test indicates that there is no statistically significant difference in the relationship between collaboration and the three dimensions of sustainable performance.

These findings raise the possibility of making some assumptions. The first can indicate a result that accompanies what has been identified in the literature, basically by Murray, Haynes and Hudson (2010), that is, that collaboration is biased for the question of social responsibility and, therefore, with the social dimension. The second, on the other hand, supports another point identified in the literature, especially the one by Fadeeva (2004), that mentions that collaboration is in line with the needs of organizations in meeting environmental issues, but this is still slightly short of the other two dimensions.

Next, we moved to the assessment of the possible interference of the control variables on the relationship between collaboration and sustainable performance. The first analysis was about the size interference (identified by number of employees) on the relationship between the collaboration for innovation and sustainable performance, as shown in the results in Table 2.

Table 2- Test of the Interference in the Relationship Between Collaboration and Sustainable Performance

Size	N	Construct	Mean	Kendall's correlation		
				τ	Sig.	R^2
Micro	18	Collaboration Sustainable Performance	3.57 3.52	0.490[A]	0.004	24%
Small	30	Collaboration Sustainable Performance	3.25 3.44	0.251[C]	0.054	6%
Medium	37	Collaboration Sustainable Performance	3.44 3.58	0.435[A]	0.000	19%
Large	27	Collaboration Sustainable Performance	3.46 3.60	0.397[B]	0.004	16%

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

In all groups of organizations classified according to size, the relationships were statistically significant, indicating that the relationship between collaboration and sustainable performance is significant, regardless of the size.

The identification of such interference in this relationship is given by the existence of statistically significant difference between the correlation coefficients from Fisher's test. The results are presented in table 3.

Table 3 - Evaluation Matrix of the Differences Between the Correlation Coefficients of Organizations, by Size, for the Relationship Between Collaboration and Sustainable Performance

	Micro	Small	Medium
Small	$z = 0.8682$ $p = 0.385$		
Medium	$z = 0.2259$ $p = 0.821$	$z = 0.8130$ $p = 0.416$	
Large	$z = 0.3524$ $p = 0.725$	$z = 0.5832$ $p = 0.560$	$z = 0.1724$ $p = 0.863$

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

Evaluating the interference in the relationship between collaboration and sustainable performance, there are no statistically significant differences between the organizations grouped according to their size.

The following analysis was on the age interference in the relationship between collaboration and sustainable performance, according to results shown in Table 4.

Table 4 - Interference Test of the Age in the Relationship Between Collaboration and Sustainable Performance

Age	N	Construct	Mean	Kendall's correlation		
				τ	Sig.	R^2
0 to 10 years	16	Collaboration Sustainable Performance	3.44 3.53	-0.150	0.418	2%
11 to 20 years	22	Collaboration Sustainable Performance	3.70 3.67	0.543[A]	0.000	29%
21 to 30 years	27	Collaboration Sustainable Performance	3.39 3.46	0.571[A]	0.000	33%
31 to 50 years	23	Collaboration Sustainable Performance	3.35 3.55	0.346[B]	0.021	12%
51 years or more	21	Collaboration Sustainable Performance	3.17 3.49	0.305[C]	0.053	9%

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

Only the first group of organizations, classified according to age, showed no statistically significant relationship, indicating that the relationship between collaboration and sustainable performance is significant only for organizations established for over 10 years. In addition, we found that the intensity of the relationship between the constructs in companies aged from 11 to 30 years was moderate average, indicating that organizations aged in this interval have higher propensity to collaborate and greater propensity to sustainable performance.

The identification of age interference in this relationship is given by the existence of statistically significant difference between the correlation coefficients from Fisher's test. The results are presented in Table 5.

Table 5 - Evaluation Matrix of the Differences Between the Correlation Coefficients of Organizations, by Age, for the Relationship Between Collaboration and Sustainable Performance

	0 to 10 years	11 to 20 years	21 to 30 years	31 to 50 years
11 to 20 years	z = 2.1523 **p = 0.031[B]**			
21 to 30 years	z = 2.3400 **p = 0.019[B]**	z = 0.1372 p = 0.891		
31 to 50 years	z = 1.472 p = 0.151	z = 0.7922 p = 0.428	z = 0.964 p = 0.337	
51 years or more	z = 1.2652 p = 0.206	z = 0.8992 p = 0.369	z = 1.0624 p = 0.288	z = 0.1390 p = 0.889

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

Upon evaluating the interference of the age in the relationship between collaboration and sustainable performance, we observe that there are statistically significant differences between organizations aged from 0 to 10 years and 11 to 20 years and between organizations aged from 0 to 10 years and organizations aged 21 to 30 years. This result and its significance indicate that the relationship between collaboration and sustainable performance suffers interference of age specifically in organizations aged from 0 to 10 years. That is, these

organizations tend to be less inclined to the relationship between collaboration and sustainable performance than organizations classified in other groups from their ages more visibly with organizations aged from 11 to 30 years.

The next analysis dealt with the interference of the capital structure and the shareholding control in the relationship between the collaboration for innovation and sustainable performance, as shown in Table 6 results.

Table 6 – Test of the Capital Structure Interference and Corporate Control in the Relationship Between Collaboration and Sustainable Performance

Capital Structure / Capital Control	N	Construct	Mean	Kendall's correlation		
				τ	Sig.	R^2
Public trading companies	13	Collaboration Sustainable Performance	3.25 3.55	0.179	0.393	3%
Others companies	99	Collaboration Sustainable Performance	3.43 3.54	0.409[A]	0.000	17%
National Control	77[*]	Collaboration Sustainable Performance	3.41 3.51	0.380[A]	0.000	14%
International Control	33[*]	Collaboration Sustainable Performance	3.39 3.62	0.484[A]	0.000	23%
* 2 companies with fifty-fifty shared control disregarded						
[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level						

Source: Developed by the authors.

In all groups of organizations classified according to capital control, relationships were statistically significant at the 0.01 level (99%), indicating that the relationship between the collaboration for innovation and sustainable performance is significant, regardless of shareholding control. However, on the question of capital structure composition (listed or unlisted), the significance level is different, possibly influenced by the number of firms in each group.

The observation of the capital structure interference and the capital control in this relationship is given by the existence of statistically significant difference between the correlation coefficients from Fisher's test. The results are presented in Table 7.

Table 7 - Evaluation Matrix of Differences Between Correlation Coefficients of Organizations for Capital Structure and Shareholding Control, to the Relationship Between Collaboration and Sustainable Performance

	Open Capital		**National Control**
Closely Held	$z = 0.7628$ $p = 0.446$	**International Control**	$z = 0.5920$ $p = 0.554$
[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level			

Source: Developed by the authors.

By evaluating the interference of capital structure and shareholding control in the relationship between collaboration and sustainable performance, there are no statistically significant differences.

The following analysis is on the interference of internationalization in the relationship between the collaboration for innovation and sustainable performance, as shown in Table 8 results.

Table 8 – Test of Interference of Internationalization in the Relationship Between Collaboration and Sustainable Performance

Internationalization	N	Construct	Mean	Kendall's correlation		
				τ	Sig.	R^2
Exports	37	Collaboration Sustainable Performance	3.38 3.58	0.352[A]	0.002	12%
Does not export	75	Collaboration Sustainable Performance	3.43 3.52	0.400[A]	0.000	16%
International Market of operation	19	Collaboration Sustainable Performance	3.46 3.62	0.563[A]	0.001	32%
National Market of operation	93	Collaboration Sustainable Performance	3.41 3.52	0.327[A]	0.000	11%

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

In all groups of organizations classified according to internationalization, relationships were statistically significant at the 0.01 level (99%), indicating that the relationship between innovation and collaboration is significant, regardless of whether the organization operates internationally or not. Despite the small number of companies in the group operating in the international market, the correlation coefficient was significant and of moderate intensity, indicating that companies with this profile feature a relationship between the constructs in a higher form.

The observation of the interference of internationalization in this relationship is given by the existence of statistically significant difference between the correlation coefficients from Fisher's test. The results are presented in Table 9.

Table 9 - Evaluation Matrix of the differences between the correlation coefficients of organizations, by internationalization, for the relationship between collaboration and sustainable performance

	Exports		National operation
Does not export	z = 0.2688 p = 0.788	International operation	z = 1.0974 p = 0.272

[A] Significant at the 0.01 level [B] Significant at the 0.05 level [C] Significant at the 0.10 level

Source: Developed by the authors.

Evaluating the interference of internationalization in the relationship between collaboration and sustainable performance, there are no statistically significant differences.

Despite the high differences on the values of determination between some groups, the test indicates a statistically significant difference only for age, having in mind that the test takes into account the number of organizations in each group. Thus, we conclude that organizational characteristics (control variables) interfere significantly in the relationship between innovation and sustainable performance only in specific age-related groups, especially in younger organizations.

5 FINAL CONSIDERATIONS

This study emerged from finding in the literature that we lack empirical evidence on the relationship between collaboration for innovation and sustainable development in organizations. Thus, the study aimed to identify how collaboration for innovation relates to sustainable performance. More specifically, we sought to: measure the intensity of the relationship between collaboration and sustainable performance; to verify whether intervening or control variable (size, age, internationalization, capital control) interfere in that relationship. Evidently, the findings obtained from the analysis of data shall be limited to the sample investigated.

From the data analysis, we conclude that the relationship between collaboration for innovation and sustainable performance is positive and significant, confirming theoretical instructions (HARTMAN; HOFMAN; STAFFORD, 1999; FADEEVA, 2004; PETZEL; ARCHER; FEI, 2010; BOS-BROUWERS, 2010; MURRAY; HAYNES; HUDSON, 2010; SARKIS; CORDEIRO; BRUST, 2010). Positive relationships, significant and not statistically different between themselves have also been found in the relationship among the three dimensions of sustainable performance and collaboration for innovation.

The intensity of the relationship between the collaboration for innovation and sustainable performance, including each of the three dimensions individually, appeared as positive weak, according to the criteria established, but defined and significant. This indicates that the relationship exists, that is, organizations that are more likely to collaborate are also more prone to sustainable performance. Due to it being a correlation analysis, we did not verify the relationship of cause and effect, according to literature, collaboration is an important factor for organizations to achieve better sustainable performance (social, environmental and economic), just as literature identifies collaboration to be important for the development/implementation of innovations.

In practical terms, the results indicate that organizations that sought to collaborate to develop or implement innovations presented better sustainable performance, regardless of size, age, shareholding control and level of internationalization.

In the case of intervening or control variables, only in the case of younger organizations, the relationship was not statistically significant, with a statistically significant difference being identified in the comparison of the intensity of the relationship between the groups. This may indicate that younger organizations, within the sample, do not yet have the consistency required to conduct these two aspects in a consistent manner so that the answers to the questions that measure the constructs would constitute a closer relationship.

In most of the comparisons between the coefficients of correlation, statistically significant differences were not found (Fisher's test), except for the variable age and for organizations aged between 11 to 30 years. This result indicates that, in these organizations, the relationship is more pronounced than in the others, favoring the assumption that, in this group of organizations collaboration and sustainable performance to be more relevant issues and worked together.

In theoretical terms, the results can be considered a breakthrough because they identify empirically the significance of the relationship between the collaboration for innovation and sustainable performance, confirming what literature has already highlighted as relevant, though without presenting evidence, *e.g.* the study by Sarkis, Cordeiro and Brust (2010) where the emphasis of this relationship is substantial, but without any empirical evidence to corroborate. In addition, the study itself is a contribution, despite all its limitations, as it sought to investigate an aspect yet little explored (collaboration for innovation) in a relatively new context for organizations (sustainable performance in its three dimensions: social, environmental and economic).

Finally, we highlight the limitations of the research, deriving from the methodological options and also from the aspects related to surveys via structured questionnaire and self-administered, as the perception of one person only in each company and the knowledge and this person's capacity of interpretation. Other limiting factors are companies' low rate of accession to research (sample size) and the sampling bias (for accession).

Our suggestions for future research: to perform a longitudinal study, which allows the identification and analysis of cause-and-effect relationships; the use of other indicators with the purpose of comparing results; the use of different statistical methods; use of qualitative

methodologies to explore non-identifiable aspects more in depth by using quantitative methodologies.

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