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The Use of Correlation and Cluster Analysis Aiming to Identify Similarities in an Innovation Diagnosis Model

Luís Filipe Serpe
Universidade Federal do Paraná – UFPR – PPGADM – Paraná - Brazil
luisfserpe@gmail.com

Itamir Caciatori Junior
Universidade Federal do Paraná – UFPR – PPGADM – Paraná - Brazil
itamircj@gmail.com

Eziel Gualberto de Oliveira
Universidade Federal do Paraná – UFPR – PPGADM - Paraná - Brazil
eziliveira@gmail.com

Abstract
This article focuses on the relevance of innovation activities to micro and small enterprises; the model proposed by Serpe (2014) and adapted from Reis (2012) is used to evaluate the degree of implementation of innovation activities in a set of companies in a specific sector. This article deals with the evaluation of innovation in Small and Medium Enterprises, sector X. The study starts with the elaboration of a diagnostic model proposed by Serpe (2014), adapted from the model of Reis (2012). Initially developed from a qualitative methodology, in this article we evaluate the relevance of different innovation activities from several dimensions through quantitative techniques. The article aims to propose the use of a statistical tool to verify the similarity and dissimilarity between the answers obtained in the companies concerning the innovation activities contained in each evaluation dimension.

Key-words:
Innovation Management; MPE's; innovation dimensions; innovation model; cluster analysis.

1. Introduction

Innovation is critical for the development of Small and Medium Businesses (SMEs). In order to implement an innovation, one must always observe the concept of commercial return, one of the focal points of innovation. (Huisman & Cort, p.1, 2003).

When working on innovation in small and medium-sized enterprises, Santos, Alves and Almeida (2007) indicate that SMEs make up an essential part of national production. However, there are few efforts to understand their difficulties and develop solutions to this group of companies. Innovation in SMEs depends on customers judgment on the paths the company must follow, and thus the demand contributes as a vital source of information.

In this line, Kuandykov and Sokolov (2010) admit that one of the most fundamental sources of information and dissemination of innovations occurs informally, in a communicative process between clients, where mass advertising has a more limited role. Rothwell and Zegveld (1982) indicate that the size of a firm can indirectly affect the outcome of an innovation process. This occurs indirectly because other factors are linked to the system, such as the type of industry and the incentive for a given sector.

As noted by Ettlie and Rubenstein (1987), small companies have high production flexibility. This means that they can adapt to the most diverse external scenarios. Thus, when observing the influence of external actors, such as suppliers and competitors, it can be seen that

there is a high capacity for adapting to external contingencies, which is an advantage for small and medium-sized enterprises.

Gunday, Ulusoy, Kilic and Alpkan (2011) explain the urgency of considering the type of innovation, the scope (scope) and which actors are involved in the study. In order for an innovation to be established and to allow the generation of value, there must be an alignment of interests among all the authors who participate in the process, and who in some way have their share of the process contribution. Moreover, according to the authors, there must also be a consensus regarding the meaning of an innovation, that is, conceptual agreement.

Thus, considering what we described in this topic, we can observe some pertinent questions: the importance of innovation for organizations in general; the diversity of innovation concepts for different organizations; the latent advantages and difficulties of SMEs in identifying innovations.

2. Theoretical background

In the theoretical background, we observed the critical themes for this study: management of innovation in microenterprises and the dimensions of innovation. The first topic describes the authors and articles used in the topic of innovation in microenterprises, which helps in the justification of why it is fundamental to analyze the innovation process in these organizations.

Concepts of Innovation Dimensions and Innovation Activities

We based our concept of innovation dimensions on a proposal for the evaluation of innovations in small companies, developed by Reis (2012). This study subdivides the innovation diagnosis process into six aspects: Method; Environment; People; Strategy; Leadership and; Results. For each of these dimensions corresponds to some questions that seek to verify the prospect of innovation for each dimension.

Regarding the concept of innovation activities, or groupings of activities, they were developed by Serpe (2014), and consider sets of activities corresponding to each dimension of evaluation as highlighted above. In other words, the model initially developed by Reis (2012), with the six overall dimensions of evaluation, was adapted in the sense that each of the proposed dimensions encompasses four sets of activities (or groupings) of activities, developed based on the researched literature especially in the Organization for Economic Co-operation and Development [OECD] (2010).

Innovation management

About the process of Management of innovation in MPE's, we applied the meta-synthesis search procedure as proposed by Hoon (2014). Thus, in the articles evaluated, we extracted the aspects necessary for the conceptualization of innovation and its relationship with the specificity of SMEs. In this way, the theoretical framework that sustains the starting question and that guides the present work remains. We explained these points in Table 1.

Table 1. The main emergent approaches in the selected studies

Authors	Context	Innovation Management Approach	SME approach
Saraceni, Resende, Serpe and Andrade (2015)	Discussion of the clustering process of organizations as a generator of innovation advantages. Comparison with small isolated companies and results in innovation indices.	Dissemination of ideas, skills, knowledge and information about a given process. Creation of advantages in competitiveness and maintenance in the market.	Small organizations organized in productive clusters, to build competitive advantages in relation to large international organizations.
Hernández, Montoya and Martinez (2014)	Diagnostic development for manufacturing in Colombian SMEs. Analysis of the Latin American context for innovation in SMEs.	Deployment of innovation systems in manufacturing using the concept of "learning process", or building skills to sustain Innovation Management	Difficulties of SMEs in developing strategies, portfolio management, processes and metrics for innovation. SMEs can not create a local knowledge base.
Figueiredo and Piana (2017)	An examination of how capital-intensive SMEs accumulate innovative and technological capabilities and the types of innovation used by capital-intensive firms in the context of the Brazilian mining industry.	Construction of innovative capabilities in SMEs through knowledge resources that enable the generation and management of technological change through skills, knowledge and experience.	Flexibility and adaptability of SMEs to build alliances with larger groups in order to foster the process of market diversification in local companies.
Martínez-Román, Tamayo and Gamero (2017)	Study in companies of Andalusia (Spain) in order to verify the impact of innovation as a factor that shows the local competitive advantages.	Association between innovation performance and local organizational characteristics and organizational environment. Analysis of contextual elements in the innovation process.	Difficulties faced by SMEs in the construction of internal competences due to the distance between these organizations and the knowledge produced in research centers.
Figueiredo and Piana (2016)	Exploration of learning connections and the role of government policies in maintaining these links.	Building local innovation capacities and establishing networks for the dissemination of knowledge and processes of organizational learning for innovation. .	The difficulties of small businesses associated with the absence of horizontal links of cooperation with universities and with other organizations.
Löfqvist (2017)	Study of three small enterprises and the development of product innovation.	Product innovation as an incremental innovation process, through the observation of information obtained directly in the market.	Flexibility, agility and responsiveness of small and medium-sized companies, as well as decision-making, facilitated communication and proximity to consumers.
Edwards (2016)	Study of a medium-sized organization that presented the need to develop and launch new products.	Development of competencies in innovation in order to serve niche markets. The use of local advantages allows competition with large organizations.	The development of innovation in SMEs depends on the development of capacities and internal competencies in the management process of Innovation in the medium and long term.

Source: The authors (2019).

3. Methodology

The model developed by Reis (2012) contemplates six dimensions. The author subdivided these dimensions into four groups of activities each, totaling 24 activities of innovation. This model, based on the description of the literature and the characteristics of the microenterprises researched, gathered in a database, allowed the specification of the content of these activities, in each dimension.

This article proposes to fill a methodological gap, regarding the verification of the importance or relevance of each activity in its dimension of analysis, or possibly to which dimension it belongs. Thus, this article aims to propose the use of a statistical tool to verify which innovation activities are most relevant to each dimension of evaluation, verifying similarities between the answers obtained during the research.

Initially, we elaborated a database from six dimensions of Innovation: Method; Environment; People; Strategy; Leadership and; Results. Next, a cluster analysis was applied, in order to observe the proximity between the responses of clusters of innovation activities.

The data to feed the system and obtain the clusters were obtained during the previous qualitative research (Serpe, 2014), and refers to a scale that addresses degrees of intensity of application of each innovation activity in the companies surveyed. Thus, it approaches a semantic differential scale, of ordinal type.

The degrees of "deployment of innovation activities" used in this study are: Non-existent; Survey; Selection; Appropriation of resources and; Implementation. It is essential to highlight that we also extracted these degrees of implementation from work developed by Reis (2012), which includes the six evaluation dimensions already highlighted in this article. Thus, each innovation activity present in each dimension receives a score, which indicates the positioning of the company in each stratum.

This database, describing these degrees of intensity of application of innovation activities, is part of the researcher's files and database. This facilitates its use in Statistical Software R, developed by the R Development Core Team (2008), where we performed the analysis. We demonstrate a model of the structure of company location within each of the phases in Table 2.

Table 2. Innovation development levels/intensity

Process maturity degree					
Dimension	**Non-existent**	**Setting-up**	**Selection**	**Appropriation of Resources**	**Implantation**
Innovation activity	**1**	**2**	**3**	**4**	**5**
Activity 1					
Activity 2					
Activity 3					
Activity 4					
Sub Total					
Activity level					

Source: Serpe (2014)

For each of the dimensions of innovation highlighted in the literature, we identified four clusters of innovation activities, also sought in the innovation literature, especially in the OECD (2005), as already highlighted in the article. These activities are constituted by actions directly related to the content of the dimension itself, and therefore are subdivisions for the operationalization of each of the dimensions.

The data collection instrument seeks to identify, within each dimension and in its related activities, the company's location regarding the degree of maturity of the process, or "implementation of innovation activities" as described by Reis (2012) and already highlighted above.

Therefore, Table 2 presents an example of how the scores of each company are identified, concerning their positioning within each cluster of innovation activities. Thus, each company has a result for each of the six dimensions. We grouped these dimensions into tables representing all the companies surveyed, with the presentation of the correct scores obtained.

As for the scale used, since it is a semantic differential scale, where it is not possible to determine the distance between each of the phases or degrees of maturity, it is characterized as an ordinal scale.

From the scores obtained by the 11 companies in each dimension of the study, a correlation and cluster analysis can be carried out, in order to verify the proximity between clusters or innovation activities.

The analysis and discussion of the data thus intend to verify the degree of similarity in the answers obtained, so that, in future works, search the reasons for there is heterogeneity or homogeneity in the answers.

We noted that the identification of similarities between two or more clusters or innovation activities does not indicate that they have a higher degree of innovation implantation, but greater proximity in the responses obtained.

Clusters of innovation activities that have more disparate responses to the other groups could thus demonstrate a shift in the content of that cluster relative to the whole cluster. Moreover, this is where the proposal of the article is inserted: to search the clusters and to verify which, or which groupings, have a greater distance of the complete set of activities of the analyzed dimension.

4. Data analysis and discussion

For the analysis of innovation activity groupings in each dimension, a correlation was performed between the clusters of activities, using the Statistical Software R (2008). We performed the analysis of clusters to observe the behavior of the answers obtained in each dimension, analyzing the similarities and dissimilarities of responses among the companies surveyed.

Statistical methods, according to Hair, Black, Babin, Anderson and Tatham (2009), should not be used without conceptual support. In the present case, only the discovery of groups among the data did not validate the existence of these groups. This validation requires analysis of the conceptual basis for validation of the most potentially relevant clusters.

Also known as the art of finding groups in data, as emphasized by Kaufman and Leonard (2009), cluster analysis in the concept of Hair et al. (2009) is similar to factorial analysis. However, while factorial analysis performs groupings based on correlations, cluster analysis performs clustering based on distance (proximity). One of the goals is to give meanings to the data collected by a researcher, for example. If a large number of observations are collected, we can group them according to the meaning intended to be given to them, a reduction in this case.

Thus, the author adds that cluster analysis involves three basic questions: the way of measuring similarity; the method of forming the clusters and; the number of groups to be formed.

As for data collection and classification of the technique, Kaufman and Leonard (2009) add that, in general, selection of "good" variables is a non-trivial task and may involve some

attempts and errors (besides knowledge of the subject and common sense). Thus cluster analysis can be considered an exploratory technique.

The technique for analysis was the Spearman correlation (Sampieri, Collado & Lucio, 2006). For Kaufman and Leonard (2009), the main difference between the Pearson coefficient and the Spearman coefficient is that, while the former seeks a linear relationship between the variables, the Spearman coefficient looks for a non-parametric relation. For this reason, this coefficient is more useful when it comes to the use of an ordinal scale, as is the case in the present research.

The grouping, according to Kaufman and Leonard (2009), begins with the assumption of n objects to be grouped by two input structures, the first representing objects by their measures or attributes (eg weight, color, sex, etc.) and the second structure, by a collection of proximities available for all pairs of objects. We classified these two types of proximities as dissimilarities, which represent how far apart are two objects from each other, and similarities, which refer to how much these objects are similar to each other.

The descriptions of these groupings begin with the construction of an array of type n x p, where the lines correspond to the objects and the columns to the attributes. Thus, in each dimension, the first table with the results for the 11 companies surveyed, the correlation table and the Dendrogram graph for the groupings of clusters found are presented.

We used the Canberra distance to obtain the absolute values of the analyzes and to verify the distances between the results obtained in the groupings, as pointed out by Jurman, Riccadonna, Visintainer and Furlanello (2009). After exposing the data in each dimension, a discussion about the correlations and results presented in the dendrogram is made, showing the groupings of activities with more disparate and less disparate answers. As shown in Table 2, the scores obtained in the following tables refer to the positioning of each company in each cluster or innovation activity in a specific dimension, as follows: None (1); Survey of resources (2); Selection of resources (3); Appropriation of resources (4) and; Application of resources (5).

Dimension Method

In the Method dimension, issues such as the use of systems and tools that support the systematic and continuous development of innovation internally within organizations are involved (Serpe, 2014; Reis, 2012). We demonstrate the scores in Table 3 and the Correlation Values in Table 4:

Table 3. The score obtained by the companies in Dimension Method

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Group 1	1	2	2	3	3	5	3	2	3	3	2
Group 2	5	4	3	5	5	5	3	4	2	3	3
Group 3	5	5	3	3	5	5	3	3	2	4	5
Group 4	1	1	2	2	2	1	3	3	2	2	2

Source: Serpe (2014).

Table 4. Correlation values to the groups in Method

	Group 1	Group 2	Group 3	Group 4
Group 1	**1.00**	**0.1148931**	**-0.03116641**	**-0.05053987**
Group 2	0.11489313	1.00	0.55630390	-0.42098457
Group 3	-0.03116641	0.5563039	1.00	-0.63950946
Group 4	-0.05053987	-0.4209846	-0.63950946	1.00

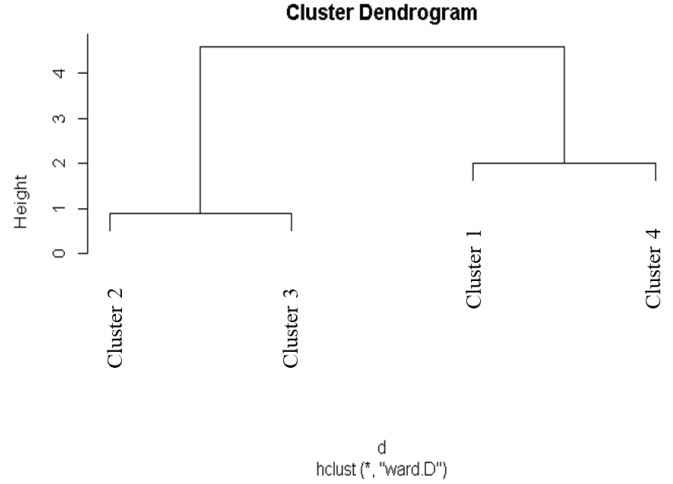
Source: The authors (2019).

In the Method Dimension, we observed a low overall correlation, although this is most critical in Activity Cluster 1 due to the negative correlation between clusters of innovation activities. Cluster 1 refers to follow-up of applied improvements, with risk assessment, results and learning through errors (Serpe, 2014).

The central point is the accomplishment of a follow-up of the accomplishment of the activities, with notes on the faults and mistakes made, allowing the later correction and readaptation.

Due to the prospect obtained in Table 4, this grouping has low adherence, being displaced in relation to the set of activities of the dimension Method, and, therefore, could be rethought or eliminated in a later revision of the model. Groups 2, 3 and 4 remain, which refer respectively to: (2) development of methods and techniques that encourage the creation of innovations from the suggestion of the Workers; (3) development of product quality, such as utility (functions), improvements in product design (use of graphic designs); (4) purchase of new machinery, new materials and organization of the company (layout) suitable for production by projects (Serpe, 2014). The Graph 1 shows an alternative representation of the results:

Graph 1. Cluster Dendrogram for the dimension Method



Source: The authors (2019).

According to the observation of Graph 1, we emphasized that there is greater proximity between groups 2 and 3, which have more similar responses concerning the other groups. This greater homogeneity of responses may suggest greater proximity between the characteristics described in clusters 2 and 3, suggesting that the other groups are more distant and heterogeneous in their results.

Dimension Environment

Within the Environment dimension, issues related to the creation, promotion and maintenance of an environmental and relationships structure that foster or encourage the creation of innovation in organizations are involved. (Serpe, 2014; Reis, 2012). We expose the results in Table 5 and Table 6:

Table 5. Scores obtained by companies in the Environment Dimension

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Group 1	1	2	3	2	4	2	2	4	2	3	3
Group 2	1	2	1	3	1	1	1	2	1	2	2
Group 3	2	2	3	2	2	5	2	2	4	3	2
Group 4	1	2	2	2	2	5	2	3	2	1	2

Source: Serpe (2014).

Table 6. Correlation values to the groups in the Environment

	Group 1	**Group 2**	**Group 3**	**Group 4**
Group 1	**1.00**	**0.3857584**	**-0.1895245**	**0.09021098**
Group 2	0.38575837	1.00	-0.2982915	-0.13363062
Group 3	-0.18952451	-0.2982915	1.00	0.60729225
Group 4	0.09021098	-0.1336306	0.6072923	1.00

Source: The authors (2019).

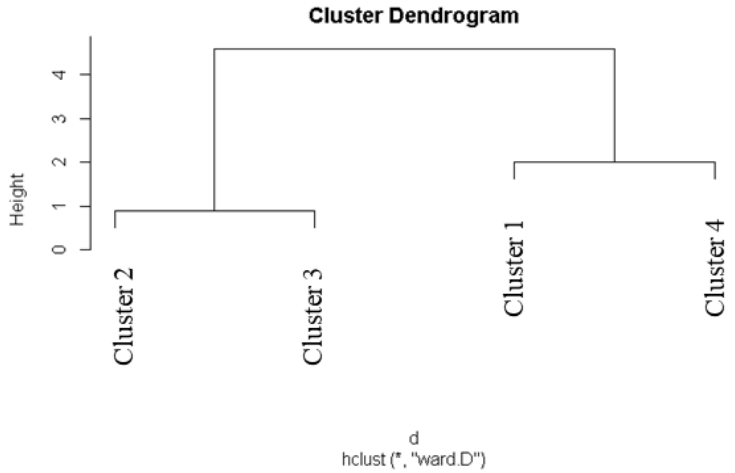
Through the analysis of Table 6, we observed that there is a low adherence of Group 1 with the other groups of activities of innovation for the Environment Dimension.

This grouping refers to the group of activities entitled creation of contribution spaces (for example, suggestions program) so that employees, customers and suppliers can contribute ideas that help in the company's innovation process, and that these contributions are evaluated by the Manager so that he can use them (Serpe, 2014).

This group is associated with issues such as activities related to stimulating the contribution of employees, such as the customers and suppliers contributions to innovation in the company.. Such grouping seems to be dislocated from the others and we could eliminate it in a later analysis of the diagnostic tool.

Groups 2, 3 and 4 remain, which refer respectively to: (2) use of activities to develop workers' creativity, allowing autonomy in decisions; (3) organization of the workplace in a way that allows the integration and interaction of people, improving communication between employees and manager; (4) use of part of the employees' work time to develop innovative activities and projects (Serpe, 2014). Graph 2 shows a visual representation of the results:

Graph 2. Cluster Dendrogram for the dimension Environment



Source: The authors (2019).

Graph 2 evaluation presents a case very similar to the first dimension: there is a significant similarity between the results obtained in clusters 2 and 3, indicating a greater homogeneity in the responses.

Dimension People

In the People dimension, we verified the process of attraction, development, retention, recognition system and rewards in Human Resources. The focus is on identifying, maintaining and learning competencies that sustain the innovation process (Serpe, 2014; Reis, 2012). Table 7 and Table 8 demonstrate the results:

Table 7. The score obtained by the companies in Dimension People

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Group 1	4	5	3	2	5	5	2	3	3	2	4
Group 2	5	2	3	2	2	5	2	3	2	2	2
Group 3	1	2	1	2	2	1	2	3	1	2	2
Group 4	1	2	2	2	2	3	2	2	2	3	2

Source: Serpe (2014).

Table 8. Correlation values to the groups in People

	Group 1	**Group 2**	**Group 3**	**Group 4**
Group 1	1.00	0.3711353	-0.20851441	-0.06944444
Group 2	0.37113525	1.00	-0.49580177	-0.11322770
Group 3	-0.20851441	-0.4958018	1.00	0.07819291
Group 4	**-0.06944444**	**-0.1132277**	**0.07819291**	**1.00**

Source: The authors (2019).

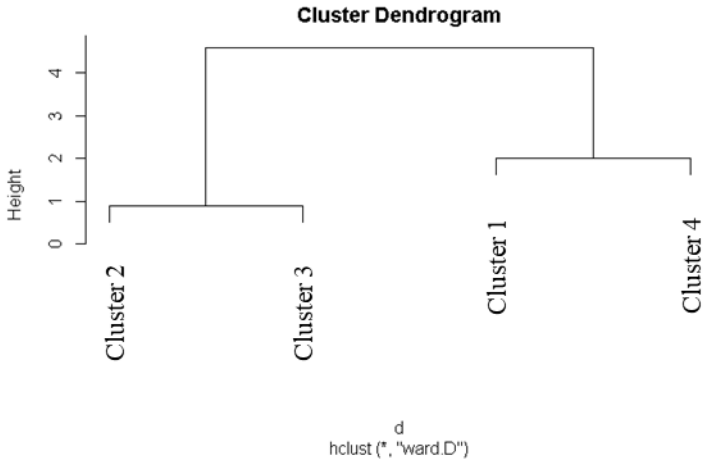
Employing the analysis of Table 8, group 4 presented the lowest adhesion with the other groupings of activities, when analyzing the 11 companies surveyed.

Thus, group 4 of innovation activities, for the People Dimension, could be eliminated, by the exclusion criterion associated with its adherence, of this dimension, thus reducing the size of the dimension to three activities only.

It is important to note that group 4 refers to the existence of financial and non-financial incentives to workers who have made suggestions on innovation, and who have worked (Serpe, 2014). This group involves activities related to the financial incentive of workers that do not come from the distribution of profits.

Clusters 1, 2 and 3 remain, which refer respectively to: (1) Hiring new employees, who already have experience and knowledge in the work to be performed; (2) Training of human resources or training of employees to carry out production tasks; (3) distribution of profits to employees according to their contribution in efforts to develop innovations in the company (Serpr, 2014). We represent the results of Table 8 in Graph 3:

Graph 3. Cluster Dendrogram of the companies for Dimension Peoples



Source: The authors (2019).

In this analysis, groupings of activities 1 and 4 have a lower homogeneity than groups 2 and 3. This corroborates with the information obtained in the correlation analysis, where group 4 obtained the lowest correlation levels in comparison to the others.

Dimension Strategy

In the Strategy dimension, we verified the mechanisms and strategic plans that address elements to promote a culture of innovation in order to create competitive advantages derived from the innovations that the companies implemented based on their strategic planning (Serpe, 2014; REIS, 2012). We demonstrate the results in Table 9 and Table 10:

Table 9. The score obtained by the companies in Dimension Strategy.

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Group 1	3	5	4	3	3	5	3	3	3	5	4
Group 2	5	3	2	4	5	5	3	5	1	3	3
Group 3	3	3	2	2	5	5	2	4	2	2	2
Group 4	4	3	4	3	2	5	3	3	4	3	3

Source: Serpe (2014).

Table 10. Correlation values to the groups in Strategy

	Group 1	Group 2	Group 3	Group 4
Group 1	1.00	-0.1101632	0.06584864	0.28571980
Group 2	-0.11016316	1.00	0.75079877	-0.10674401
Group 3	0.06584864	0.7507988	1.00	0.03681051
Group 4	**0.28571980**	**-0.1067440**	**0.03681051**	**1.00**

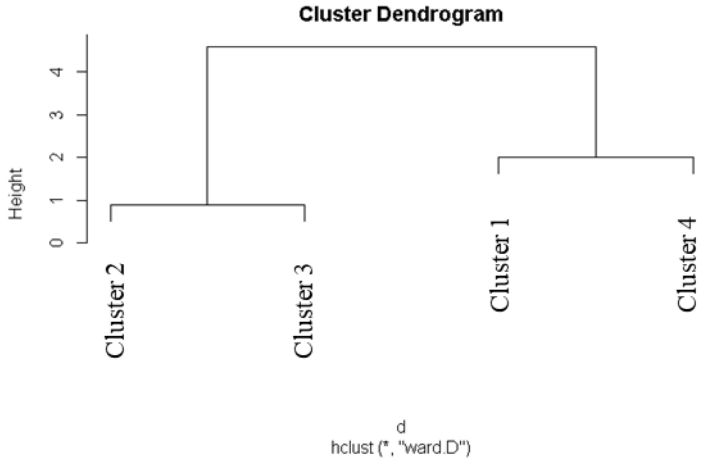
Source: The authors (2019).

By the analysis of Table 10, we perceived that there is more than one grouping with low adherence to the other groups of activities. However, cluster 4 appears to have a low degree of adhesion in general. This indicates greater distancing relative to the other groups, at least concerning the responses obtained.

Group 4 encompasses the activity of advertising (folders, TV, internet, radio), anticipating competition and seeking new market segments (such as other economic classes) (Serpe, 2014).

Clusters 1, 2 and 3 remain, which refer respectively to: (1) use of new marketing techniques; (2) speed in the distribution of the product to customers and; (3) realization of contact with partners who help in the innovation process. Moreover, according to Serpe (2014), these activities involves the knowledge of the existence of entities that assist in the process of implementation of innovation in companies, mainly in the technical personnel and financial support. Graph 4 shows a visual representation of the results:

Graph 4. Cluster Dendrogram for the dimension Strategy



Source: The authors (2019).

In the analysis of Graph 4, we again observe the greater proximity between activity clusters 2 and 3, with the other groups of activities having a greater distance from the answers obtained. This corroborates the results obtained in the correlation analysis, that is, the greater distance of the responses obtained in clusters 1 and 4.

Dimension Leadership

In the Leadership dimension, we observed how the entrepreneur/owner acts in the execution of the innovation objectives. Also, there are activities focused on decision-making in innovation, in order to promote and implement a Strategic Management of Innovation and competitiveness (Serpe, 2014; REIS, 2012). We exhibit the results in Table 11 and Table 12:

Table 11. The score obtained by the companies in the Dimension Leadership

	A	B	C	D	E	F	G	H	I	J	K
Group 1	5	3	3	2	2	5	2	3	2	2	2
Group 2	3	4	2	3	3	4	3	2	3	2	2
Group 3	1	1	1	1	2	3	2	2	1	3	2
Group 4	1	3	3	2	2	1	2	2	2	2	2

Source: Serpe (2014)

Table 12. Correlation values to the groups in Leadership

	Group 1	Group 2	Group 3	Group 4
Group 1	1.00	0.41478068	0.04950738	-0.5416026
Group 2	0.41478068	1.00	-0.09240617	-0.2106059
Group 3	**0.04950738**	**-0.09240617**	**1.00**	**-0.4021998**
Group 4	-0.54160256	-0.21060588	-0.40219983	1.00

Source: The authors (2019).

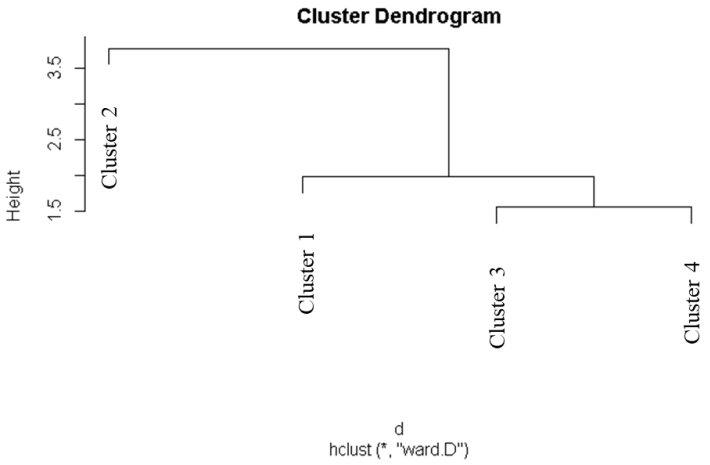
Analyzing Table 12, we observed the low adhesion again to Group 3, where all correlations are negative, demonstrating the low degree of adhesion of the cluster in comparison to the whole set.

Group 3 refers to activities such as affiliation/cooperation with trade associations, trade unions, APL's, other institutions and companies, aiming at the development of innovation projects with these partners. Also shows the search for codified knowledge in the form of theoretical works in the production area of the company, such as scientific articles, international production standards, metrology and regulatory requirements (Serpe, 2014). In a later analysis, such a group could be withdrawn or reassessed, to reduce or simplify the system.

Clusters 1, 2 and 4 remain, which refer respectively to: (1) Signature of specialized newspapers and magazines in the production area of the company; (2) participation in fairs and conferences in the area, allowing access to new forms of production and market trends regarding product and materials used and; (4) activities that involve targeting, targeting, and resource separation (budgeting) designed and aligned to achieve innovation (Serpe, 2014).

Here, we have issues such as the creation and definition of activities to develop the objectives and targets that will guide all the operations carried out by the company and the definition of the resources to be used in innovation improvements, such as financial, material and human resources, necessary for compliance of activities. Graph 5 shows the visual results of the analysis:

Graph 5. Cluster Dendrogram for the Dimension Leadership



Source: The authors (2019).

Here it is observed that there is a substantial similarity between groups 3 and 4, and the two with group 1. Conversely, correlation analysis shows that group 2 is the one that has the most significant distance from the others.

Dimension Result

In the Results dimension, we verify the exit activities resulting from innovations already implemented in the organization. The literature describes these activities such as possible improvements in innovation also made by the entrepreneurs that can generate significant positive results on the overall performance of the organization (Serpe, 2014; Reis, 2012). Table 13 and Table 14 demonstrate the results to Dimension Result:

Table 13. Score obtained by the companies for the Dimension Result

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Group 1	1	1	1	1	1	5	1	1	1	1	1
Group 2	2	2	2	2	4	5	3	2	4	2	2
Group 3	4	3	3	2	3	5	3	3	3	3	3
Group 4	3	1	1	1	1	2	1	1	1	2	2

Source: Serpe (2014).

Table 14. Correlation values to the groups in Result

	Group 1	**Group 2**	**Group 3**	**Group 4**
Group 1	1.00	0.6829480	0.8032193	0.2631174
Group 2	0.6829480	1.00	0.5485570	-0.0838579
Group 3	0.8032193	0.5485570	1.00	0.5987995
Group 4	**0.2631174**	**-0.0838579**	**0.5987995**	**1.00**

Source: The authors (2019).

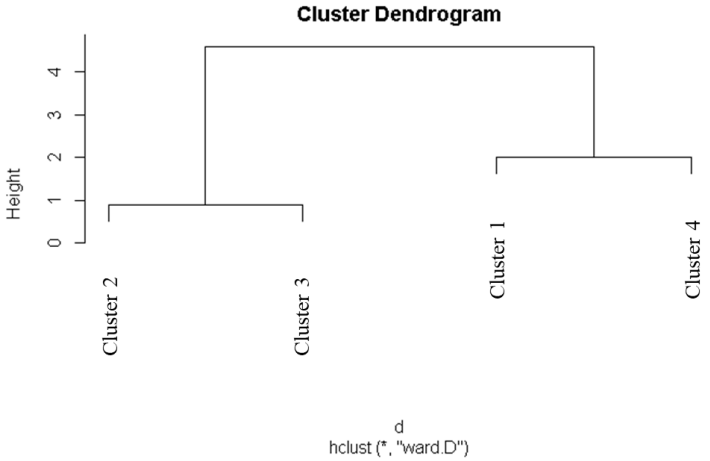
Using the analysis of Table 14, we observe that, for the Results dimension, the highest values of adherence among the clusters of activities were generally obtained, showing that there are substantial cohesion and coherence among the activities listed in the dimension.

However, obeying the simplification criteria of the model within the objective of the article, group 4 has the lowest adherence and should be re-evaluated or restructured for use in future research.

Group 4 refers to the creation of a method to evaluate mistakes made, with learning and correction of faulty parts (Serpe, 2014). It involves the follow-up of the innovation project execution process, with the annotation of the failures occurring, when they differ from the planned, that is, when the execution goes beyond the scope of the initial project.

Clusters 1, 2 and 3 remain, which refer respectively to: Existence of a method to verify that the results obtained with the innovations were achieved; Implantation of full, budgeted and managed plans/projects and; Focusing on innovations to reduce production costs and increase profitability. (Serpe, 2014). Graph 6 shows the Dendrogram of the results:

Graph 6. Cluster Dendrogram for the Dimension Result



Source: The authors (2019).

Corroborating the information obtained in the correlation analysis, we can observe that the clusters that obtained the highest similarity were 2 and 3, again showing that there is a greater distance in the responses obtained in clusters 1 and 4.

5. Conclusions

In this work, we selected a group of innovation activities for exclusion, which seems to have less relation to the general meaning and conceptualization of that specific dimension.

An important point to be addressed here is that, when crossing the information obtained in the analysis of correlation with the formation of the clusters, we observed that in five of the dimensions, the heterogeneous groupings coincide with the groupings that have the lowest correlation in general, indicating so that groupings of activities obtained more heterogeneous responses.

We noted, however, that cluster correlation and analysis was used because of the small number of the sample used, and that more robust methods, such as factorial analysis, would require a larger sample. Even so, the statistical methodology used here provides a way to demonstrate the cohesion between component activities in each dimension of Innovation

assessment. This methodology also can serve as the basis for a review or test of requirements methodology that involves activities consistent with the definition used in each dimension.

Although only the use of correlation and clustering may be insufficient, the objective of the article was reached, e.g., the use of a statistical tool that helps characterize the activities used in each dimension, and the simplification of a diagnosis model in Innovation.

The proposal is that future work can explore the reasons for the heterogeneity between responses in clusters of activities that are more distant from each other or have a lower correlation in responses to other groups.

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6. References

Edwards, T. V. (2017). SME Innovation: a case study. *International Annual Conference of the American Society for Engineering Management, ASEM 2017*. Huntsville; EUA;

Ettlie, J. E., & Rubenstein, A. H. (1987). Firm size and product innovation. *Journal of Product Innovation Management*, *4*(2), 89-108.

Figueiredo, P. N., & Piana, J. (2016). When "one thing (almost) leads to another": A micro-level exploration of learning linkages in Brazil's mining industry. *Resources Policy*, *49*, 405-414.

Figueiredo, P. N., & Piana, J. (2018). Innovative capability building and learning linkages in knowledge-intensive service SMEs in Brazil's mining industry. *Resources Policy*, *58*, 21-33.

Gunday, G., Ulusoy, G., Kilic, K., & Alpkan, L. (2011). Effects of innovation types on firm performance. *International Journal of production economics*, *133*(2), 662-676.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Análise multivariada de dados*. Bookman Editora.

Hernandez, M. C., Montoya, M. V., & Martínez, J. F. (2014). Development of a model for evaluating the npd process in SMEs: A Latin American experience. *Procedia CIRP*, *21*, 449-454.

Hoon, C. (2013). Meta-synthesis of qualitative case studies: An approach to theory building. *Organizational Research Methods*, *16*(4), 522-556.

Huisman, K. J., & Kort, P. M. (2003). Strategic investment in technological innovations. *European Journal of Operational Research*, *144*(1), 209-223.

Jurman, G., Riccadonna, S., Visintainer, R., & Furlanello, C. (2009). Canberra distance on ranked lists. In *Proceedings of advances in ranking NIPS 09 workshop* (pp. 22-27). Citeseer.

Kaufman, L., & Rousseeuw, P. J. (2009). *Finding groups in data: an introduction to cluster analysis* (Vol. 344). John Wiley & Sons.

Kuandykov, L., & Sokolov, M. (2010). Impact of the social neighborhood on the diffusion of innovation S-curve. *Decision Support Systems*, *48*(4), 531-535.

Löfqvist, L. (2017). Product innovation in small companies: Managing resource scarcity through financial bootstrapping. *International Journal of Innovation Management*, *21*(02), 1750020.

Organization for Economic Co-operation and Development [OECD]. (2005). Manual de Oslo: diretrizes para coleta e interpretação de dados sobre inovação. Oslo: OECD.

Martínez-Román, J. A., Tamayo, J. A., & Gamero, J. (2017). Innovativeness and its influence on growth and market extension in construction firms in the Andalusian region. *Journal of Engineering and Technology Management*, *43*, 19-33.

R Development Core Team (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Serpe, L. F. (2014) *Proposta De Metodologia De Requisitos Para A Inovação Em Micro E Pequenas Empresas.* Master Degree Dissertation. UTFPR (Universidade Tecnológica Federal do Paraná). Ponta Grossa, PR.

REIS, Dálcio R. (2008) *Gestão da Inovação Tecnológica*. Barueri, SP: Manole.

REIS (2012). *Caderno de Avaliação da Gestão da Inovação*. Prêmio Nacional da Inovação, Mobilização Empresarial pela Inovação.

Rothwell, R., & Zegveld, W. (1982). Innovation and the small and medium-sized firm. *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*.

Sampieri, R. H.; Collado, C. F.; Lucio, P. B. (2006) *Metodologia da pesquisa*. (3th. ed). São Paulo: McGraw-Hill.

Lemos da Silveira Santos, L., César Alves, R., & Nunes Tavares de Almeida, K. (2007). Formação de estratégia nas micro e pequenas empresas: um estudo no centro-oeste mineiro. *Revista de Administração de Empresas*, *47*(4), 1-15.

Saraceni, A. V., de Resende, L. M. M., Serpe, L. F., & de Andrade Junior, P. P. (2015). A comparative analysis between clustered and non-clustered companies using innovation indicators. *IFAC-PapersOnLine*, *48*(3), 155-160.