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Analysis of innovation in the red ceramic industry segment: an application of the innovation radar

Análise da inovação no segmento da indústria de cerâmica vermelha: uma aplicação do radar da inovação

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Abstract

The purpose of this article is to analyze the degree of maturity of innovation in ceramic industries in the city of Itajá/RN. The research was configured as an exploratory and descriptive approach, in which, through semi-structured interviews with the managers of eight companies in the segment, these were analyzed for the thirteen dimensions of the Innovation Radar. The results of the research show that all companies adopt strategies and carry out actions that promote innovation, even if in a subtle and punctual way, aiming only at the correction and optimization of administrative and operational functions. Despite this, the conclusions indicate that it is possible to verify that the innovations that were mostly adopted were focused on processes, with improvements being made to optimize different internal aspects of the organization (productive and administrative), reduce production costs and increase the final quality of the products offered.
Keywords: innovation; innovation radar; red ceramic industry.

Resumo
O objetivo desse artigo é analisar o grau de maturidade da inovação em indústrias de cerâmica da cidade de Itajá/RN. A pesquisa se configurou como uma abordagem exploratória e descritiva, na qual, por meio da realização de entrevistas semiestruturadas com os gestores de oito empresas do segmento, estas foram analisadas quanto as treze dimensões do Radar da Inovação. Os resultados da pesquisa apontam que todas as empresas adotam estratégias e realizam ações que promovem a inovação, mesmo que de forma sutil e de caráter pontual visando apenas a correção e otimização de funções administrativas e operacionais. Apesar disso, as conclusões indicam que é possível verificar que as inovações que foram adotadas, em sua maioria, tinham como foco os processos, sendo realizadas melhorias para otimizar diferentes aspectos internos da organização (produtivo e administrativo), reduzir custos na produção e aumentar a qualidade final dos produtos ofertados.
Palavras-chave: inovação; radar da inovação; indústria de cerâmica vermelha.

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1 INTRODUCTION

With the greatest competitive intensification of the market, companies have found in innovation a means to create and develop new skills and knowledge that allow them to adopt new management and production strategies to adapt to this market condition (TOMAÉL; ALCARÁ; Di CHIARA, 2005; KOTLER; KELLER, 2012). By implementing autonomously, intentionally and pro-actively new products, process and methods of marketing and management in their business practices, innovative companies are able to increase their productivity, establish greater differentiation between competing products, expand *marketing share* and foster innovative capacity (OECD, 2005; PAREDES, SANTANA, FELL; 2014).

However, even if it is possible to identify specific innovative behavior, it is of significant complexity to determine how innovative companies are, that is, measure their level of innovation. According to Matesco (1993), this is due to the lack of a consensus among the most varied studies in this area about which variables and forms of empirical analysis should be used to explain the innovative effort. Still, even with these limitations, models were developed in order to evaluate innovation, each of which addressing a specific set of areas related to it.

Given all the models developed, the Innovation Radar stands out for allowing companies to have a broad view of their level of innovation from the analysis of thirteen dimensions that cover all organizational aspects, such as offer, customers, processes and presence (SAWHNEY, WOLCOTT, ARRONIZ; 2006; BACHMANN, DESTEFANI; 2008). Especially, with the highest applicability in small and medium-sized enterprises (SMEs), as they are more likely to increased of the competition, this model allows to identify the dimensions in which the greatest innovations are adopted and, consequently, the ones which are under-developed and that could be worked on by companies as a way to establish greater differentiation in relation to their industry competitors (WALLS, SANTANA, FELL, 2014; CARVALHO *et al.*, 2015).

It is possible to find in the literature several studies that used the Innovation Radar in the analysis of the innovative effort of SMEs of some kind of segments of the economy, such as: metalworking and auto parts (PAREDES; SANTANA; FELL, 2014; CUNHA; CARVALHO; BARTONE, 2015), agribusiness (CARVALHO, et al. 2015), retail trade and furniture industry (OLIVEIRA, 2014), restaurants (ARAÚJO; ARAÚJO, 2013), personal aesthetics (SIMÕES, 2015), information and communication technology (CAVALCANTI FILHO; OLIVEIRA; CAVALCANTI, 2012), textile-clothing chain, construction and services (SILVA NETO; TEIXEIRA; 2011; 2014). However, none of these deals with the analysis of the degree of maturity of innovation in ceramic industries. It is precisely the absence or, at least, the scarcity of research on Innovation Radar, focusing on ceramic industries, that justifies the present research.

In view of this, this research is characterized as a case study that adheres to the examination of the innovative activity, through the Innovation Radar, of SMEs of the red ceramic industry segment, aiming to measure the degree of innovation maturity, how the innovative process takes place and which innovations were adopted. As object of study, the choice of SMEs in the red ceramic industry was due to this being an important segment, promoter of the national economy, due to being the main supplier of material for buildings, roofs and sanitation for all regions of Brazil, which makes it fundamental for the development of construction, a sector of representative importance (23.9% in 2018) for the GDP – Gross Domestic Product of the national industry (ANICER, 2014; PORTAL DA INDÚSTRIA, 2018).

At the economic level of Rio Grande do Norte, this is a segment formed by approximately 184 companies, which operate mostly in the poles of Vale do Açu, Grande Natal and Seridó, where they have an important contribution in the generation of employment and income in localities with low socioeconomic development and with significant presence of low-skilled labor (OLIVEIRA, 2011; SANTOS, 2015). Specifically, it was analyzed the innovative behavior in SMEs located in the municipality of Itajá, due to this being one of the main producers both of the pole in which it is inserted (Vale do Açu) and also at the state level - this when we consider the amount of companies installed and the productive potential (SANTOS, 2015).

This work is divided into the following sections: theoretical framework, which addresses the studies related to innovation, to the Radar of innovation model and the red ceramic industry; methodology, addressing how the study was carried out; results and discussions, presenting the characterization of companies, measurement of the degree of maturity of innovation and analysis of innovative actions adopted; and, finally, the final considerations of the study.

2 THEORETICAL FRAMEWORK

2.1 Innovation Radar

For Farias et al. (2014), the current economic environment requires that companies seek to continually renew themselves, mainly in relation to their attitudes and purposes, thus, those who wish to remain in the market and excel in relation to their competitors resort, for example, to the improvement or creation of new products and modification of the ways of doing things, aiming to obtain higher levels of productivity and quality. Because of this, innovation becomes a key point every day for companies to overcome their own limitations and become progressively more productive and differentiated.

One of the precursors in studies related to innovation was Schumpeter (1984), which, in his macroeconomic view, demonstrated that innovation allows to overcome the frontier of possibility of production of goods and services of an economy, being a practical tool of changes that makes it possible to provide competitive advantages to companies over other competitors in the market. According to Hitt, Ireland and Hoskisson (2011), the ability of innovation to give greater competitive potential to companies would occur by introducing new products or services to the market as well as by making changes in the organizational structure itself.

The Innovation Radar is a strategic model of innovation evaluation, developed in order to measure the degree of maturity of innovations in micro and small organizations, but also presents feasibility in its application in larger companies. Having been originally designed by Sawhney, Wolcott and Arroniz (2006) with twelve dimensions, the Innovation Radar was structured in four main axes that involve classes, key dimensions that serve as the anchor of the business, and their subclasses representing biases to be achieved, thus we have: offer (platform and solutions), customers (relationship and value capture), processes (organization and supply chain) and presence (network and brand).

Subsequently, Bachmann and Destefani (2008) introduced to the Innovation Radar, in the presence class, a thirteenth dimension, the innovative ambience, because they understand that an organizational environment conducive to innovation is a condition *sine qua non* to innovate, moreover, this made the model more complete and comprehensive. According to Sawhney, Wolcott and Arroniz (2006), from the analysis of each of these dimensions it would be possible to develop and improve business strategies in order to realize innovations in areas where companies have greater disadvantages.

For a better understanding of each dimension, Coelho (2012) and Mendonça (2014) demonstrate the concepts used for each dimension. These can be seen in Frame 1.

Frame 1 - Conceptualization and directions of the dimensions of the Innovation Radar

DIMENSIONS	CONCEPTS	TARGETING
Offer	Products and services offered by the company	Innovating along this dimension requires the creation of new products and services that will be evaluated by customers
Platform	Set of common components, assembly methods, or technologies that serve as a building structure for the product and service portfolio	Exploiting the "power of decentralization", using modularity to create a diversity of products and services faster and cheaper than the standard of individual items
Trademark	It works the symbols, words and marks with which the company communicates the principles to customers	Leverage or extend your brand in a creative way
Solutions	A combination of integrated customization of products, services and information that solve a customer's problems	This creates value for customers through the breadth of choices and the depth of integration of the different elements
Clients	Individuals or organizations that use or consume the company's offerings to meet certain needs	Innovation in this dimension occurs through the discovery of new customer segments or unmet needs
Customer experience	It considers all customers seen, heard and recognized in the most different experiences while they interact with the company at all times	The company needs to rethink the organization/customer interface
Value capture	Mechanisms that the organization uses to recapture the value of innovations	Uncovering unexplored company revenue streams, developing new pricing systems, and expanding the ability to capture value from customer and partner interactions
Processes	Configurations of business activities used to conduct internal operations.	The redesign of processes to gain efficiency, increase quality or faster cycles. Such changes may require relocations of processes or divisions at the beginning or end of them
Organization	Ways in which the company is structured, its partnerships and the role of employees and their responsibilities	Rethinking the scope of the company's activities, as well as redefining the roles of people, responsibilities and incentives of the different business units and individually
Supply chain	Sequence of activities and agents moving goods, services and information from origin to delivery of goods and services	Simplification of the flow of information through the supply chain, by changing its structure or by improving the collaboration between its participants
Presence	It deals with the distribution channels that the company employs to bring the offers to the market and the places where they are offered to customers for purchase or use	Creating new points of presence or using existing ones in a creative way
Network	The network connects the company and its products to customers, making the resources used bring an agile and effective communication between company and customer	Network improvements that will bring more value to the company's offerings
Innovative ambience	Set of tools, processes and attitudes that promote or motivate employees to create something or improvements	Implementation of mechanisms such as a suggestion program that encourage employees to present their ideas

Source: Adapted from Coelho (2012, p.52-53) and Mendonça (2014, p. 26).

As can be seen in Table 1, for companies to be able to innovate properly within each dimension, there are necessary directions for this to occur more effectively. However, the demand for innovation will depend on the need of each company, in whose organization related characteristics, such as activity, sector and segment of the market, size, etc., should be taken into account when making this decision.

Regarding the SMEs, the focus of this study, they have more specific needs for innovation in their activities, but naturally face greater difficulties to innovate (OECD, 2005). Feldens, Maccari, and Garcez (2012), and Néto and Teixeira (2014) highlight that these difficulties are related to the legal barriers, the cost and availability of capital, both internal and external, which in turn results in a lack of adequate investment in Research and Development (R&D); low technical knowledge; lack of a tradition of investing in the development of technology, result of a cultural aversion to risk; high costs of technology acquisition, added to the difficulties of access credit lines; lack of physical infrastructure and adequate staff, among other things. However, when these companies are able to overcome these limitations and adopt certain innovative behavior, it becomes possible to achieve superior performance and turnover compared to non-innovative companies (SEBRAE/SP, 2009).

2.2 Red Ceramic Industry

The red ceramic industry is part of the productive circle of civil construction that integrates a range of industrial segments, being responsible for the supply of ceramic materials - blocks, roof tiles, solid bricks, sanitation pipes, filling elements (structural slabs), among others - used in more than 90% of masonry and roofing built in Brazil (ANICER, 2015; SEBRAE, 2015).

According to Nascimento (2011), the ceramic industry segment presents an expressive territorial capillarity, being present in practically all Brazilian regions. The main determining factor for the location of these industries is the quality level of the raw material (clay) that will be used, which provides favorable conditions for the manufacture of products; subsequently, as secondary factors, the availability of labor, local infrastructure, tax incentives and local market demand are taken into account (ETENE, 2010). In this sense, according to data from the Brazilian Association of Ceramics - ABCERAM (2011) and Technical Office of Economic Studies of the Northeast - ETENE (2010), the South and Southeast regions concentrate most of the industries of this segment, where there is a great demand for ceramic material, mainly associated with civil construction. However, the other Brazilian regions also show development in this segment, with the Northeast being in a prominent position, presenting a productive capacity responsible for one fifth of national production (REINALDO FILHO, BEZERRA, 2010).

Although technological improvements adopted in recent decades have enabled companies to increase the quantity and quality of products produced, the enterprises in this segment are characterized by still presenting a low level of technological infrastructure, compared to the production standard found in the main countries producers, predominantly the intensive use of labor in technically obsolete processes (NASCIMENTO, 2011; ETENE, 2010). Directly linked to this condition prevail in the segment micro to medium-sized family organizations, many of them informal, which have specific needs regarding their innovations, especially with regard to productive improvement, energy efficiency, compliance with environmental and mineral legislation, as well as related to administrative management itself (MME,

2009; NASCIMENTO, 2011; ANICER, 2015).

With regard to the productive circuit of the state of Rio Grande do Norte, one of the main strongholds of this segment in the Northeast region, the same characteristics observed in the segment as a whole prevail. There are approximately 180 companies organized in four production poles (Grande Natal, Seridó, Vale do Açu and West Region) formed due to the presence of large clay sedimentary basins in these locations, together with the availability of firewood, used by 96% of these companies for use in the manufacturing process as an energy vector (ETENE, 2010; CTGAS-ER, 2011). In addition, since most of these companies do not have a financial structure that allows them to invest in organizational improvements, this ends up leading to a technological lag, with the presence of manual techniques; disqualified labor, being predominantly the presence of people with incomplete elementary education; low level of Business Management; in addition to precarious working conditions and lack of strict quality standards of final products and inputs used (NASCIMENTO, 2011; CTGAS-ER, 2011).

In order to overcome these limitations, state producers are organizing together with public institutions in order to develop programs that provide an improvement of production and processes through improvements in procedures, equipments and training of employees (AGORA RN, 2018). In this sense, the Innovation Radar becomes a useful tool for analyzing these ceramic industries, by providing information about all organizational aspects that can be used in the development of organizational innovation strategies.

3 METHODOLOGICAL PROCEDURES

This research is characterized as an exploratory, descriptive and multi-case study, because through the collection of data from different sources of information in companies (semi-structured interviews, non-participant observation) the purpose was to analyze the degree of innovation maturity in red ceramic industries from the description of the dimensions of the Innovation Radar model. As for the approach to the problem, this study is presented as qualitative-quantitative, that is, qualitative since the results weave the verification of the relationship between reality and the object of study, seeking inductive analytical interpretations by the researcher, and quantitative by making a measurement of the Degree of Innovation Maturity (DIM) with respect to the dimensions of the Innovation Radar.

Data were collected through primary sources, in which, from a preliminary survey of the companies of the segment in activity in the municipality, semi-structured interviews were conducted with the managers of eight companies. Regarding the research instrument, it was developed based on the model used by Néto (2012), consisting of 44 questions grouped by dimension of the Innovation Radar. The survey sample represents 60% of the companies in operation, whose choice occurred in a non-probabilistic way for accessibility and convenience.

After data collection, two types of content analysis were performed for data interpretation: qualitative and quantitative. In the qualitative analysis, the data obtained in the interviews were ordered through the ATLAS.ti 8 software, to which codes were assigned that identify the direction of innovative behavior present in companies. After coding, networks of their interrelationship were built, related to each of the dimensions of the Innovation Radar and, finally, a network of codes related to the dimensions studied was built. Subsequently, a description of the networks created based on the information obtained in the interviews was performed.

In the quantitative analysis, for each of the questions (variables) of the research instrument was assigned, based on the

information provided by the managers, a score according to the following criteria: five (5) points when the variable is systematic or common; three (3), when the variable is occasionally present, and one (1), when the variable is not present. Subsequently, two indices are calculated: (a) the Degree of Innovation Maturity of the company (DIM), obtained by the arithmetic mean of the score obtained by the companies in each dimension; (b) and the Degree of Maturity of the General Innovation (DMGI), indicating the innovation of all companies, being calculated from the division of the sum of the values of the means of each dimension of all companies by the total number of dimensions.

For the classification of companies, the scale proposed by Néto and Teixeira (2011) was used. Thus, from the score obtained in the indexes, the companies were classified into three types: systemic innovators, because they practice innovation management (DIM≥4); occasional innovators, because they innovated in the last three years, but without systematization of the process (3≥DIM 4); and little or no innovators (1≥DIM 3).

4 RESULTS AND DISCUSSIONS

4.1 Characterisation of companies

The research sample is composed of eight companies in the red ceramic industry segment of the municipality of Itajá (RN). The analyzed ceramics act essentially in the manufacture of four families of products: brick, roof tile, tile and structural and cladding blocks. Between 72 (C4) and 36 (C5/6/7) employees are employed in each plant, which produces an average of approximately 1.056 million units per month. This production is destined for the domestic market, mainly the Metropolitan Region of Natal, but also for other states in the Northeast region, such as Ceará, Paraíba and Alagoas. The data concerning the characterization of the sample are contained in Table 1.

Table 1 - Characterization of the analyzed companies of the segment of the red ceramic industry of the municipality of Itajá (RN)

Companies	Operation (years)	Number of employees	Products	Production one thousand units/month)
C1	19	37	Brick, roof tile, tile	1.000
C2	26	58	Structural blocks	1.200
C3	49	46	Brick, roof tile, tile and cladding	1.000
C4	18	72	Brick, roof tile, tile	1.600
C5	13	36	Brick and tile	1.100
C6	16	36	Brick and tile	800
C7	15	36	Brick and tile	1.000
C8	11	42	Brick, roof tile, tile	750

Source: survey data (2019).

4.2 Degree of Innovation Maturity and actions taken

Table 2 shows the scores obtained by the companies as to the respective dimensions of the Innovation Radar, these being used to calculate the Degree of Innovation Maturity (DIM) of each company and the Degree of General Innovation Maturity (DGIM). The

dimensions that obtained values equal to or greater than three are highlighted, evidencing the minimal existence of occasional innovation in the analyzed organizations.

Table 2 - Score of the degree of innovation maturity of companies according to each dimension

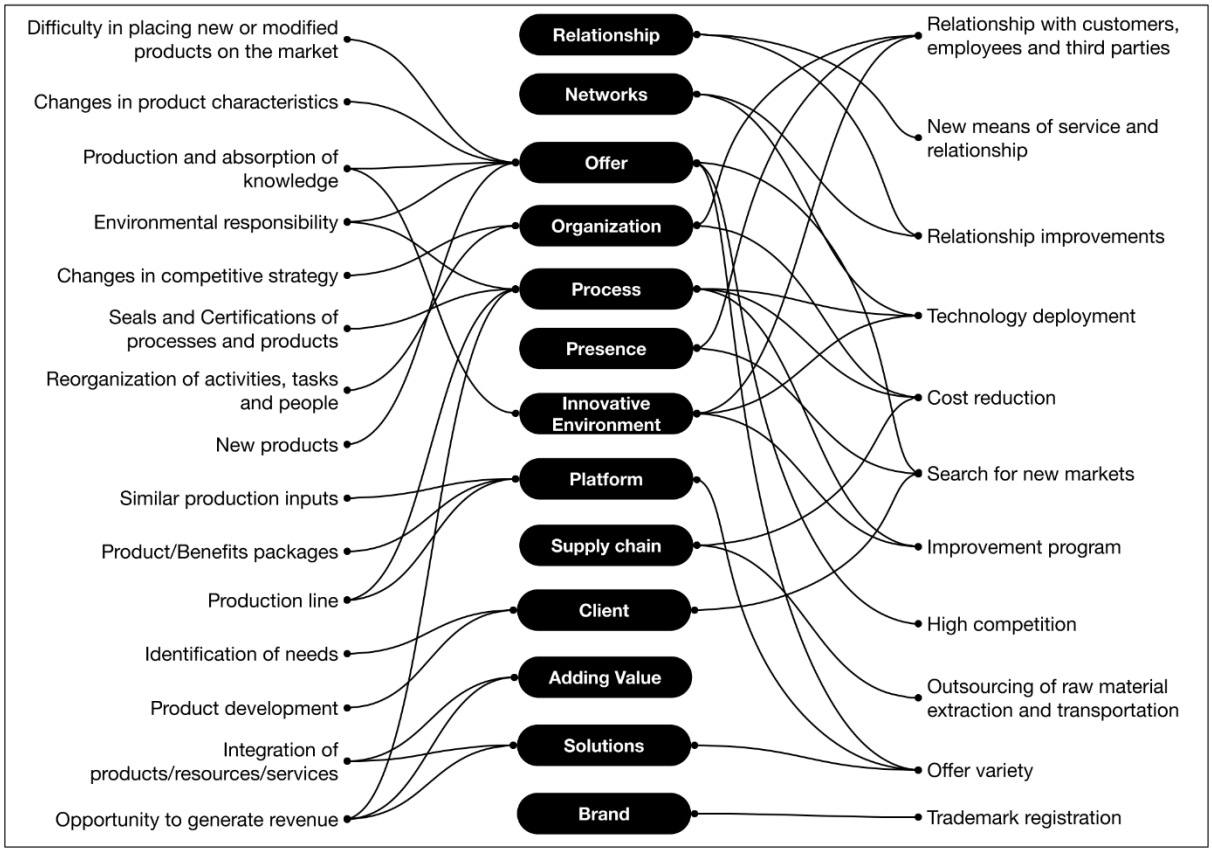
	Scoring companies in each dimension								
Size/companies	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**DIM**
Offer	2,0	2,7	2,3	1,3	1,3	2,3	1,7	2,0	**2,0**
Platform	3,0	3,7	3,7	3,0	3,0	3,0	3,0	3,0	**3,0**
Brand	3,0	3,0	3,0	3,0	1,0	1,0	1,0	1,0	**2,0**
Clients	1,0	2,6	2,2	1,0	1,8	1,8	1,0	1,8	**1,8**
Solutions	1,0	3,0	1,0	1,0	1,0	1,0	1,0	2,0	**1,0**
Relationship	2,0	4,0	4,0	1,0	2,0	2,0	2,0	2,0	**2,0**
Adding value	1,0	3,0	1,0	1,0	1,0	1,0	1,0	1,0	**1,0**
Process	2,1	3,3	2,7	1,3	1,9	1,9	1,9	1,3	**1,9**
Organization	2,3	2,3	1,7	1,0	1,0	1,7	1,0	1,0	**1,3**
Supply chain	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	**1,0**
Presence	2,0	3,0	2,0	1,0	1,0	1,0	1,0	1,0	**1,0**
Network	1,0	3,0	3,0	1,0	3,0	3,0	3,0	3,0	**3,0**
Innovative ambience	2,8	2,3	3,0	2,1	1,8	2,0	1,8	2,0	**2,1**
Degree of Innovation Maturity	**1,9**	**2.9**	**2,5**	**1,4**	**1,6**	**1,8**	**1,6**	**1,7**	**2,0**

Source: survey data (2019).

Based on the classification scale used in this study, we can verify that companies in this segment are little or no innovative (DGIM 3) due to the lack of innovations of great organizational impact in the last three years. However, the results showed that the Platform dimension presents greater innovation efforts, resulting from the concern of companies to make small improvements in the production process.

The information provided was analyzed through the ATLAS.ti 8, which made it possible to assign codes that indicate the directions the innovations adopted. Each dimension contains a set of own codes, however, the same code may be present in another dimension, that is, when the cost reduction code occurs in the Process, Organization and Supply Chain dimensions, this means that the innovative actions carried out focused on minimizing costs involved in the production process and organizational structure. In Figure 1 it is possible to visualize the general network of codes containing the dimensions, their respective codes and their multiple connections with the dimensions.

Figure 1 - General network of codes of innovations adopted by companies



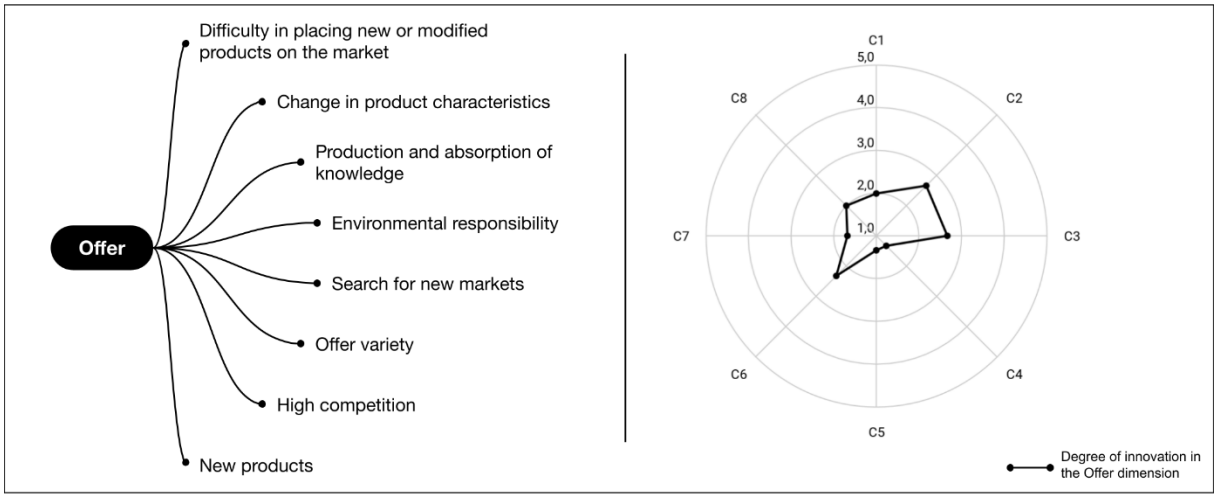
Source: Survey data (2019).

To better understand the related innovative actions and their interrelationships, the variables used to measure each dimension, the innovations found, the individual networks and the graphical representation of the score of the companies in each dimension of the Innovation Radar will be presented.

4.2.1 Supply Dimension

Evaluated in relation to the search for new markets, production of new products, changes in design, use of new materials or components and concern with the impact of the product on the environment, it was found that companies innovate little or did not innovate in this dimension (DIM 3). The concern to expand the markets was a behavior identified in six companies, which began to produce new products to meet the demand of customers in other states of the Northeast region. Companies do not act on the development of new products, with completely new features and configurations, only use standardized models already registered by regulatory bodies. Half of the companies have added new products in their products' *mix* by means of knowledge and technological resources contained in the company itself or acquired from third parties. It should be noted that the supply of new products was limited by two factors: a drop in the economic activity of the construction sector and little opening of the segment itself to new products, even with superior performance. Figure 2 contains the codes and the score obtained by the companies in the Offer dimension.

Figure 2 - Degree of innovation maturity of companies and Offer dimension codes



Source: survey data (2019).

4.2.2 Platform Dimension

The analysis of this dimension considered the following aspects: use of production lines, components used in products and variation of manufactured products. The results showed that companies occasionally innovated in this dimension (DIM≥3). There is a preference of companies for single production lines that are adapted to the manufacture of more than one family of products, seeking to reduce costs with several resources (space, equipment, employees, etc.). In addition, automation of production steps, use of new materials and acquisition and improvement of equipment were measures adopted to improve the platform, reducing costs, accelerating production and minimizing environmental impacts caused by the activity. All companies offer their products in more than one version, which differ in relation to the dimensions and color of the product (due to failures in the stage of burning parts, some products acquire lighter shades, so they are sold cheaper instead of being discarded). Figure 3 contains the codes and the score obtained by the companies in the Platform dimension.

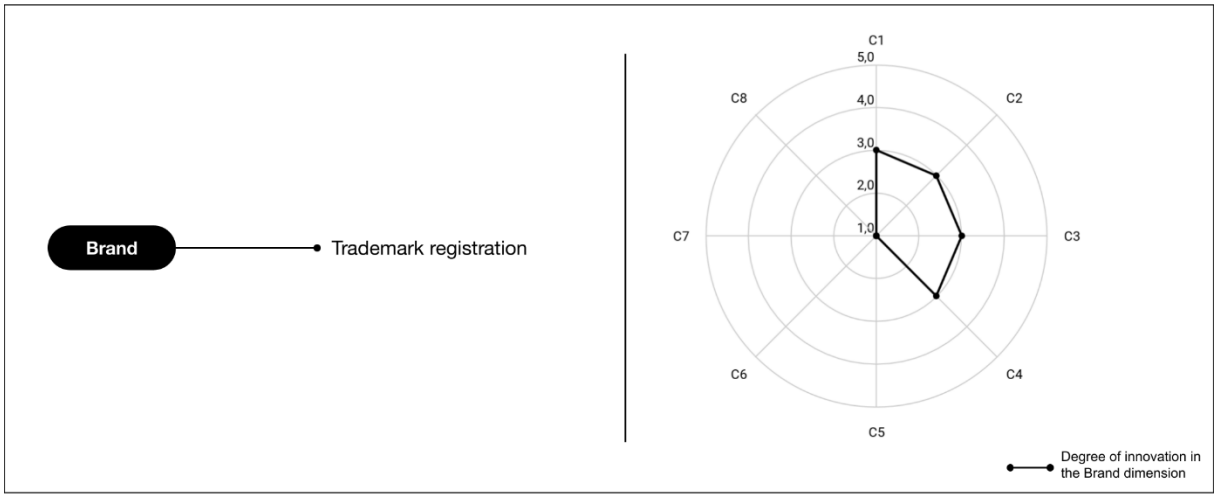
Figure 3 - Degree of innovation maturity of companies and Platform dimension codes

Source: survey data (2019).

4.2.3 Brand Dimension

Analyzed regarding the registration and use of the trademark, it was observed that only half of the companies (which had longer operating time) carried out innovations in this dimension, through the registration of the trademark and visual identity in regulatory bodies. According to Brazilian Micro and Small Business Support Service (SEBRAE, 2016), trademark registration makes it possible to legally protect the company against the plagiarism of competitors seeking to gain space in the market using an already consolidated brand, thus the owners are guaranteed the right to exclusive use of their brand throughout the national territory. Companies that did not conduct registration did not identify benefits from such an action. In addition, the use of the brand, in all companies, is used only on products. Figure 4 contains the codes and the score of the companies in the Platform dimension.

Figure 4 - Degree of innovation maturity of companies and Brand dimension codes



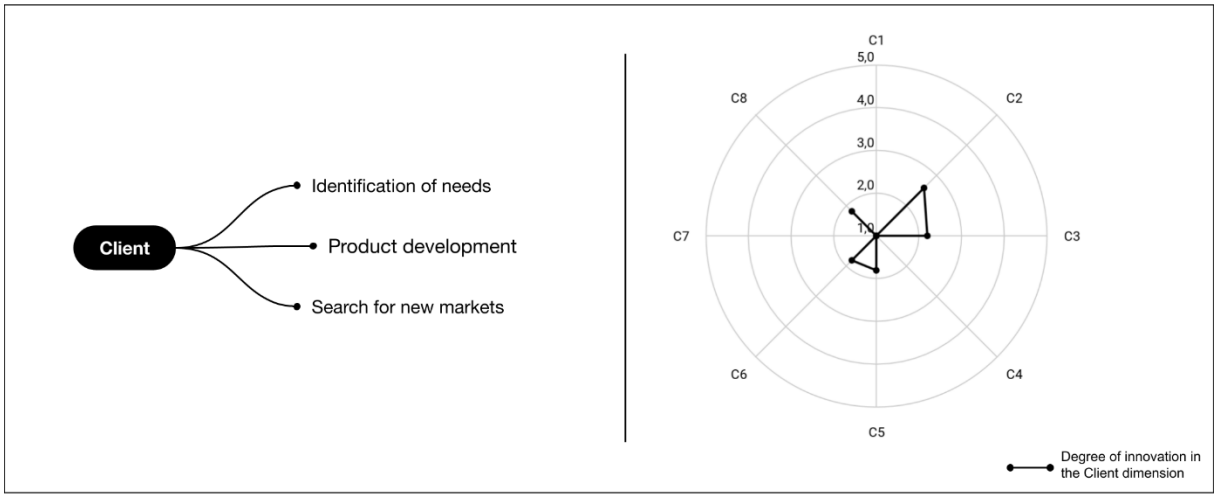
Source: survey data (2019).

4.2.4 Customers Dimension

In the evaluation of companies regarding their willingness to identify customer needs and new markets and openness to customers' participation in the development/improvement of products, it was found that there were few or no innovations in this area (DIM 3). Companies do not present any kind of systematic method of identifying the needs of customers, but when they have some specific demand they resort to ceramics for analysis of production feasibility. In this sense, customers usually participate in the product development and modification process. According to Ensslin (2011), the greater the understanding of the needs, desires and expectations of customers, the greater the chance that the adopted innovations are perceived as adding value and generating return for the organization.

It should be noted that this attitude of the companies is due to the fact that they act attending to a fixed portfolio of customers, thus being high concern in offering products that meet the needs of these. It turns out that the existence of this fixed portfolio ends up being a justification used not to seek new markets. In cases where companies began to deliver their products in other Brazilian states, this occurred mainly to continue serving customers who operate in Rio Grande do Norte and who migrated to other locations. Figure 5 contains the codes and the score of the companies in the Customers dimension.

Figure 5 - Degree of innovation maturity of companies and Customers dimension codes

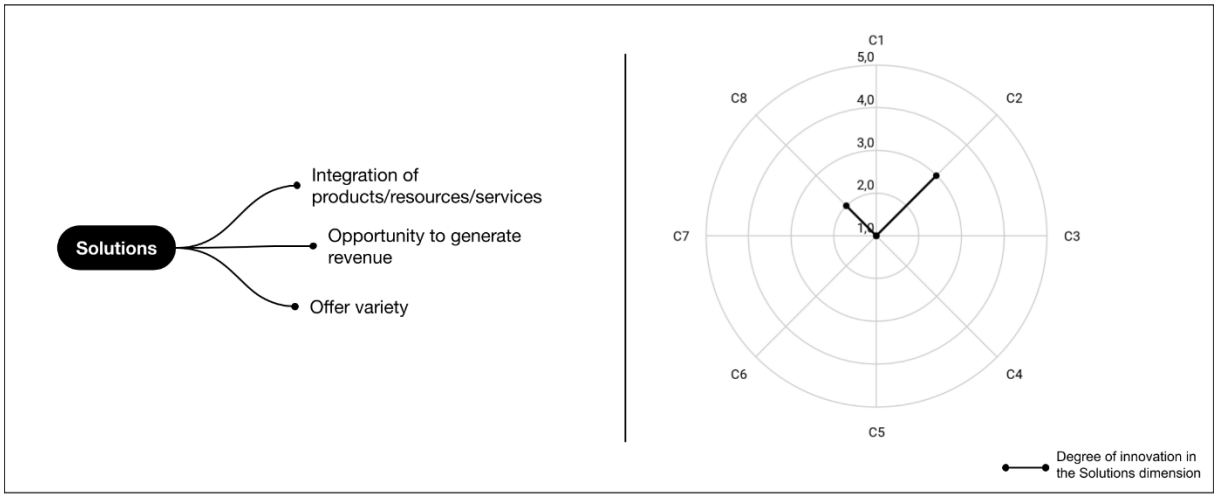


Source: survey data (2019).

4.2.5 Solutions Dimension

The incorporation of products, services and support to the main product of the company aims to create new solutions to customers adding value to the offer, in a process called *"servitization"*, making the company stand out competitively from the exploration of new market opportunities (VANDERMERWE; RADA, 1988; ALMEIDA; MIGUEL; DA SILVA, 2011). In this sense, the companies were analyzed regarding the offer of complementary products and aggregation of resources/products/services. Only two companies carry out the customized combination of services capable of solving the needs of their customers: one guides customers about the best use of products to reduce costs during the initial project of the work; the other carries out the hiring of charter trucks for customers from other states. For Brax (2005), manufacturing companies that integrate services together with their products are able to facilitate their sales, increasing customer loyalty to the company and building growth opportunities in markets with little room for differentiation. Figure 6 contains the codes and the score of the companies in the Solutions Dimension.

Figure 6 - Degree of innovation maturity of companies and Solutions dimension codes

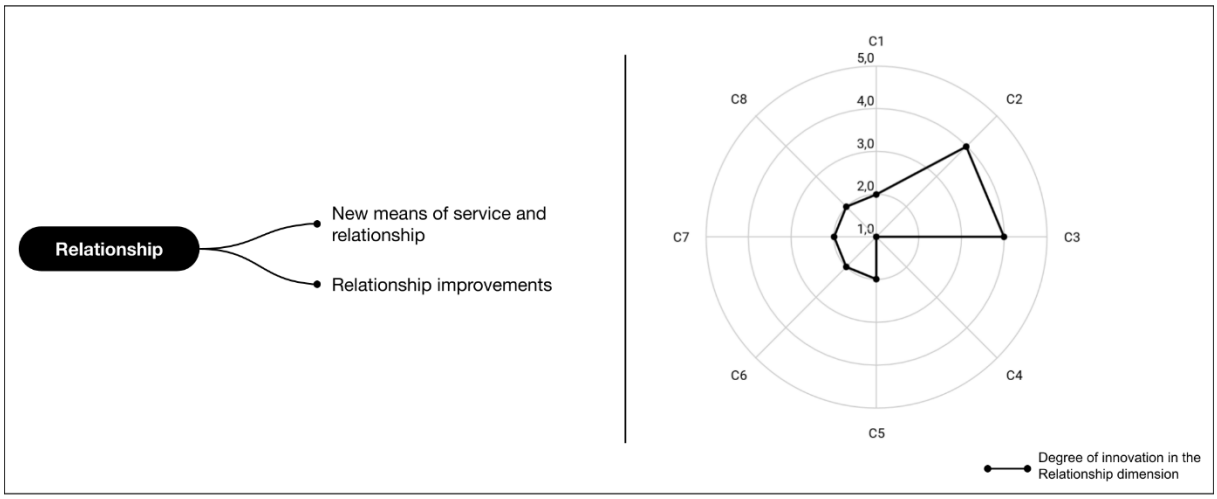


Source: survey data (2019).

4.2.6 Relationship Dimension

Regarding the use of facilities and resources to improve contact with customers and the implementation of computer resources to facilitate exposure and communication with current and new buyers, it is observed that most companies do not innovate in these aspects, there are no radical transformations in the way companies relate to customers. Five companies used gifts, business cards, souvenirs etc. as a strategy to please customers and thus keep them loyal to the company, as well as to stimulate them to publicize the company through word of mouth marketing. All companies primarily use telephone and email as a means of communication, but half of companies have introduced social networks and instant messaging applications to streamline communication and thus make more agile requests for orders and feedbacks. According to Araújo (2013), the uses of new communication tools have been widely used in small and medium-sized companies that seek to improve the relationship with their customers, but also with others stakeholders. Figure 7 contains the codes and the score of the companies in the Relationship dimension.

Figure 7 - Degree of innovation maturity of companies and Relationship dimension codes

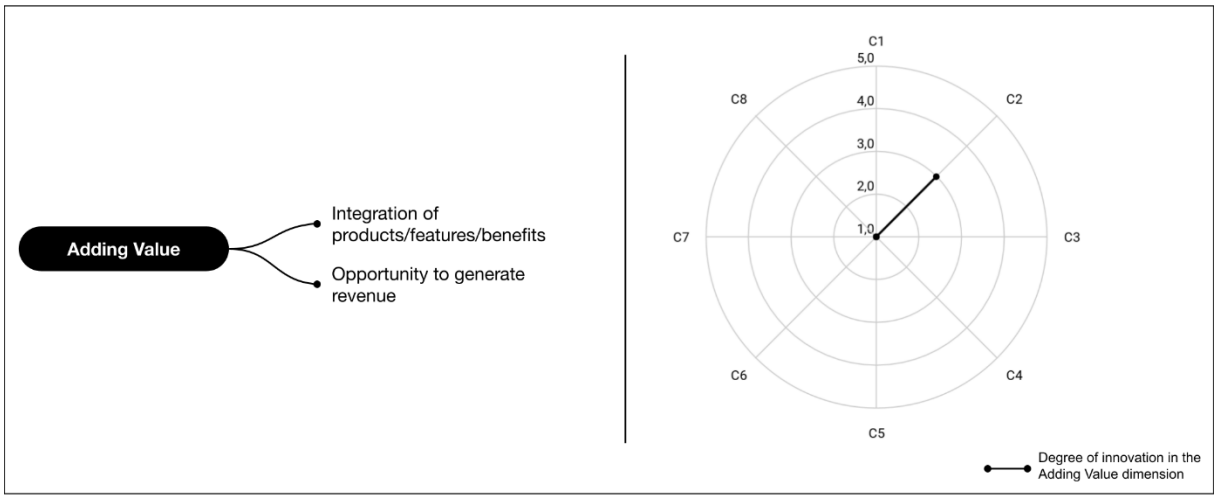


Source: survey data (2019).

4.2.7 Value Aggregation Dimension

In the evaluation of aspects related to value aggregation, such as the generation of revenue from existing resources and delivery of value through new solutions, it is found that there is no concern of companies to innovate in this area. From an industry perspective, value is understood as the monetary importance of the set of benefits (technical, economic, services, etc.) which company delivers upon receipt of payment for the offer (ANDERSON; NARUS, 1999). However, in the case of the ceramic industry, as it is about intermediate products of low technological complexity, the possibilities of adding value are limited, being restricted to characteristics such as design, durability, resistance etc., which can be easily copied by other companies. The only ceramic that has innovated in this area has added value to its products by offering "benefit packages" and integration with technical services. Figure 8 contains the codes and the score of the companies in the Value Aggregation dimension.

Figure 8 - Degree of innovation maturity of companies and Value Aggregation dimension codes

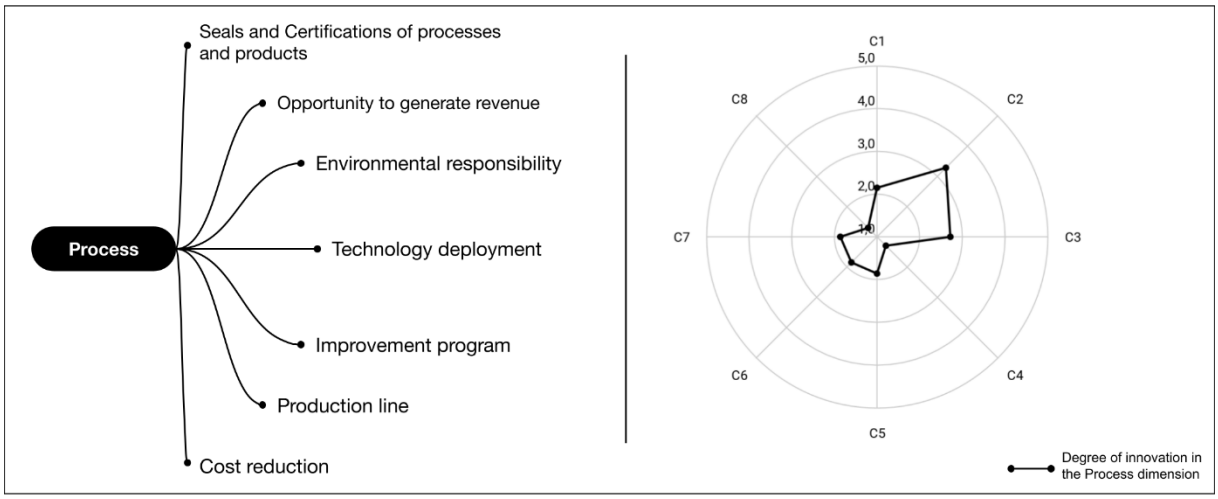


Source: survey data (2019).

4.2.8 Process Dimension

For research of this dimension were considered changes in processes, use of new management practices, resources and inputs. The results demonstrate the presence of little or no innovation in this area (DIM 3). Most companies seek to improve their processes by purchasing or modifying equipment, generating more efficiency and speed at all stages of manufacturing. With an environmental and economic concern, some companies have adopted changes in energy vectors and intend to deploy equipment for the reuse of manufacturing tailings. The use of re-engineering techniques, total quality management and good practice manual are measures present in only three ceramics. Those who did not use any of these techniques claimed the need for high financial investments and intense information control, being an obstacle to implementation. Figure 9 contains the codes and the score obtained by the companies in the Processes dimension.

Figure 9 - Degree of innovation maturity of companies and Processes dimension codes



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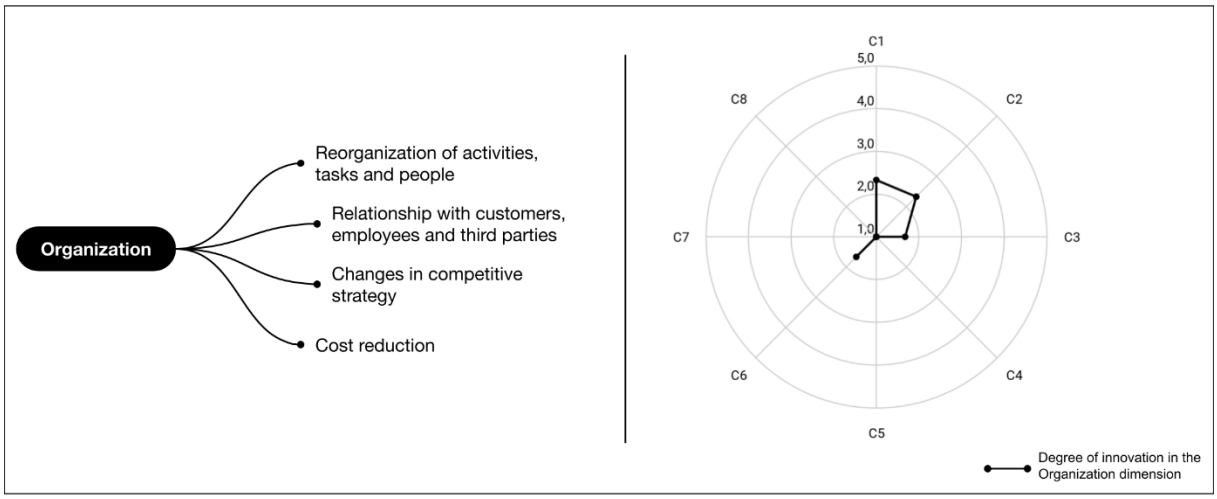
Source: survey data (2019).

4.2.9 Organization Dimension

Innovations related to this dimension, according to Tigre (2006), consist in implementing new organizational methods within the "operational routine of a company, in the organization of work or in its external relations". Thus, through the investigation of changes in the competitive strategy, creation of partnerships with third parties and reorganization of internal activities, it was observed the presence of few innovations in this dimension. No company has made changes to the competitive strategy, but they have tried to establish new differentials from partnerships with third parties for employee training, technical consulting and market research. Some companies have made changes in the allocation of employees and tasks to improve organizational efficiency. Figure 10 contains the codes and the score obtained by the companies in the Organization dimension.

Figure 10 - Degree of innovation maturity of companies and Organization dimension codes

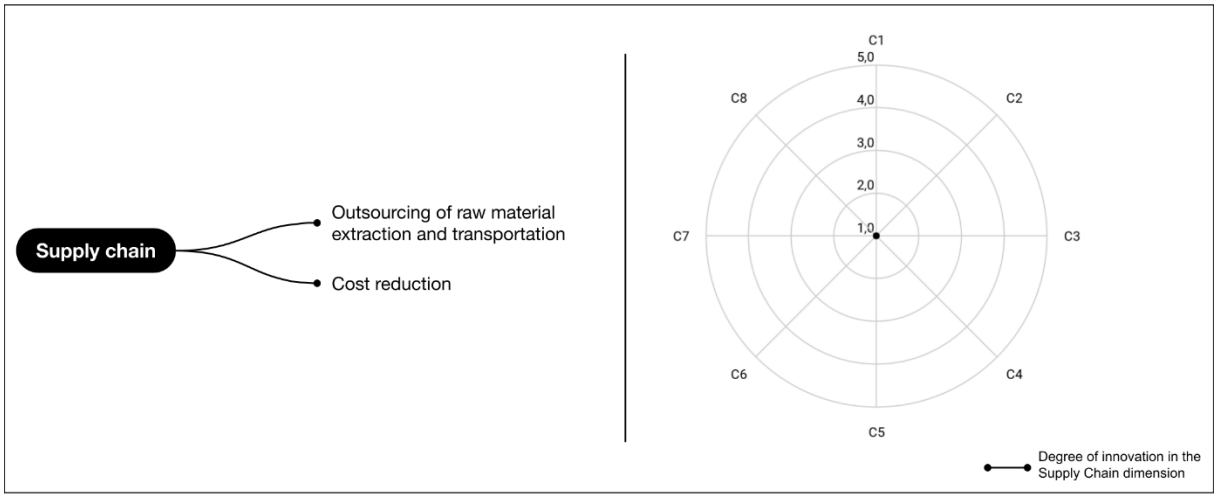


Source: Survey data (2019).

4.2.10 Supply Chain dimension

The supply chain refers to the sequence of activities related to the movement of materials from origin to delivery, covering aspects related to business logistics. None of the companies have innovated in this dimension, being the DIM=1. Ceramics require only two third-party resources, firewood and clay. Suppliers close to the factory are sought in order to minimize the costs involved in transporting the deposits to the factories. In addition, large stocks of clay and firewood are kept, as this provides a desirable improvement in the physicochemical properties of these materials and also ensures protection against price fluctuation. Figure 11 contains the codes and the score obtained by the companies in the Supply Chain dimension.

Figure 11 - Degree of innovation maturity of companies and Supply Chain dimension codes

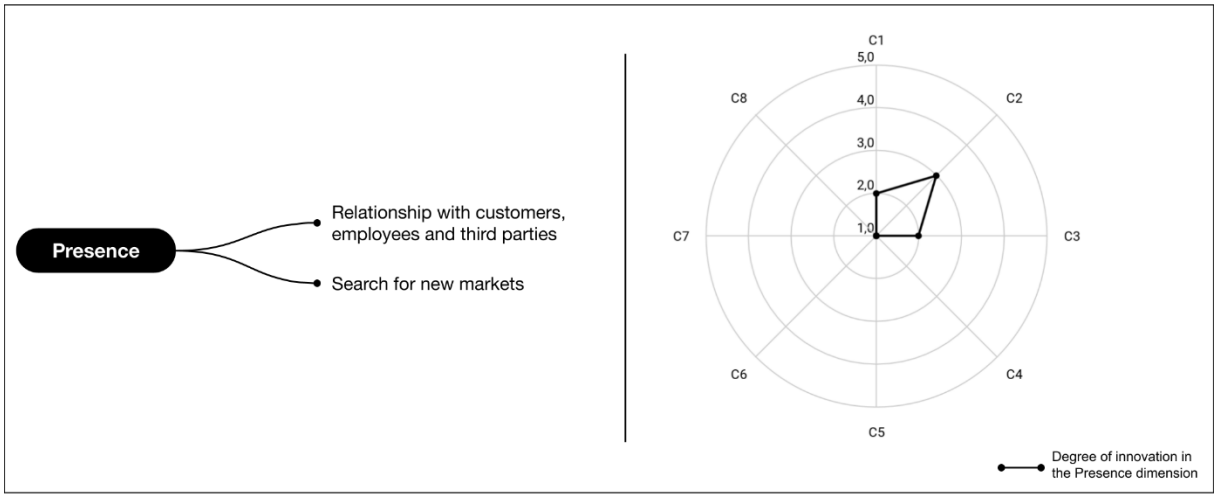


Source: survey data (2019).

4.2.11 Presence Dimension

From the analysis of factors such as the creation of new channels and points of sale and the use of distributors/representatives for external sales, it was observed that only a few companies innovated in this dimension, adopting only improvements related to sales and communication channels. The presentation and sale of the products take place mainly at the headquarters of the ceramics, through face-to-face visits of customers, phone calls and emails. However, some companies have already started to use websites, social networks and instant messaging apps to facilitate access to those customers who live in other regions and also speed up the fulfillment of orders. Except in a single company, all others do not have sales representatives as a means of external sales due to the high costs of maintaining a representative, operational inability to meet high demand relative to current, and increased risk of default with unknown customers. Figure 12 contains the codes and the score obtained by the companies in the Presence dimension.

Figure 12 - Degree of innovation maturity of companies and Presence dimension codes

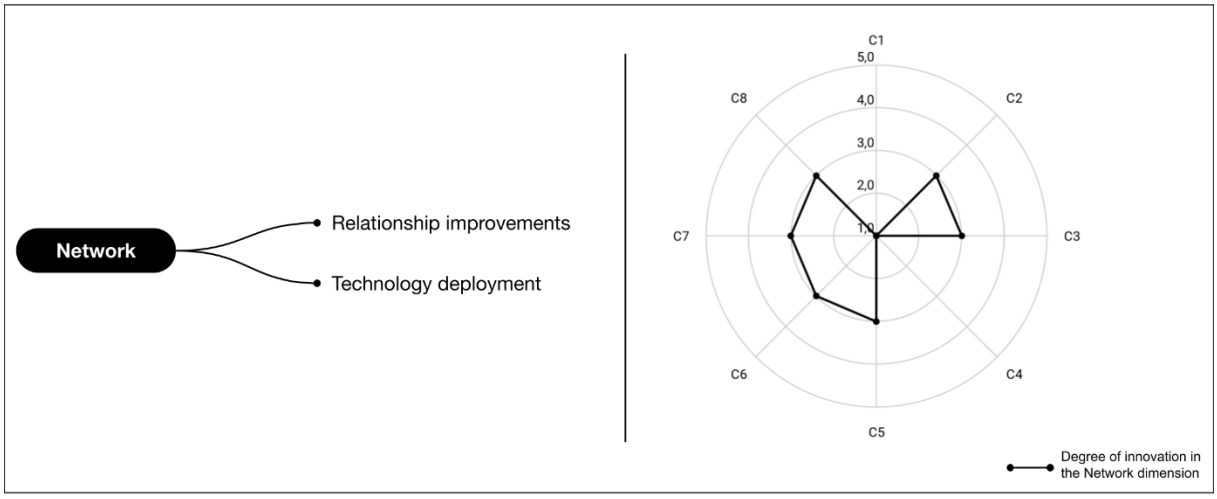


Source: Survey data (2019).

4.2.12 Network Dimension

The analysis of this dimension consists in identifying whether companies have adopted some way of listening and talking to their customers, using information technology or not, to promote faster communication between both. As stated earlier, some companies have started to use IT resources, such as social networks, websites and apps, to have greater efficiency in receiving orders, sending documents and response agility regarding possible complications. In addition, these new means allow, at very low costs, to expand the company's exposure as to its certifications, qualities and benefits of products, customer works and actions of social and environmental responsibility. Figure 13 contains the codes and the score obtained by the companies in the Network dimension.

Figure 13 - Degree of innovation maturity of companies and Network dimension codes



Source: Survey data (2019).

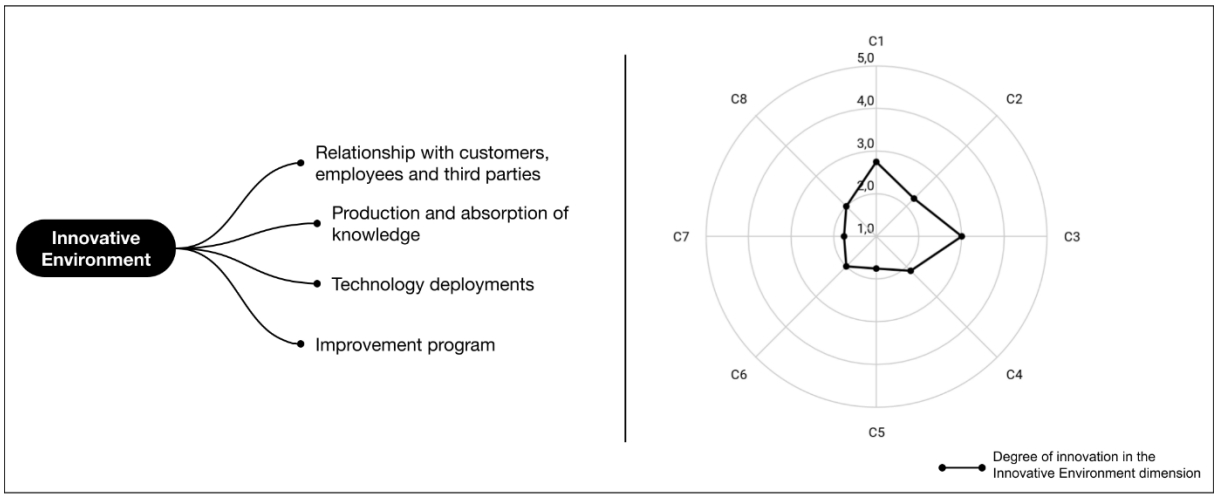
4.2.13 Innovative Ambience Dimension

The innovative ambience dimension involves the analysis of the set of tools, processes and attitudes adopted by companies in order to stimulate these employees to develop new solutions or propose new organizational improvements. According to Barbosa and Teixeira (2003), micro and small-sized companies have been undergoing changes in their organizational environment that end up requiring a new profile of employees, who can quickly adapt to new technologies and who are more committed to organizational performance. Based on this, this dimension was verified regarding the relationship with technical institutions, absorption and creation of knowledge, development of product projects and openness for collaboration of employees.

Companies often seek in public and private entities support for the qualification and training of employees, in addition to conducting consulting on the management of organizational resources. Only half of the companies sought and absorbed knowledge or technologies with suppliers, customers or in industry events, being focused on the improvement of machines, processes and products. Regarding the openness to participation of employees with suggestions of ideas, none of the companies had a form of opinion collection system, however three of them consider the implementation of such a system in the future. Figure 14

contains the codes and the score obtained by the companies in the Innovative Ambience dimension.

Figure 14 - Degree of innovation maturity of companies and Innovative Ambience dimension codes



Source: survey data (2019).

Given the above, it was possible to realize how important it is to the application of the Innovation Radar tool in companies, because it is possible to verify how much they are applying some necessary actions to remain competitive in the market. According to what was described in the methodology, the mean obtained in the dimensions resulted in the measurement of innovation through the degree of organizational innovation for each of the dimensions of the Innovation Radar, being possible to perceive a variability between one dimension and another.

5 CONCLUSIONS

Fundamental to the understanding of business innovation is the understanding that it has evolved over time, no longer having only a technological vision to cover a perspective focused on the use of knowledge in order to develop new forms of organizational structuring, productive and commercialization of goods and services. In this sense, the present study analyzed the degree of innovation maturity in ceramic industries of Itajá/RN through the Innovation Radar methodology that proposes, according to Sawhney, Wolcott and Arroniz (2006) and Bachmann and Destefani (2008), that this can be verified from thirteen dimensions.

The results obtained allow us to understand that the analyzed industries do not have an innovative behavior, a factor that could be a differential since they do not have large competitive differentials. Factors such as the absence of people with technical qualifications in management, financial limitation for investment in R&D and acquisition of sophisticated equipment, and an organizational environment that does not provide stimuli for the improvement of employees and their participation with suggestions for improvements, were the determining factors for the low degree of innovation maturity of the companies analyzed. However, the innovations that were adopted, for the most part, focused on processes, improvements were made to optimize different internal aspects of the organization (productive and administrative), reduce production costs and increase the final quality of the products offered. However, it should be noted that these innovations did not have the capacity to generate a great economic impact, being more for gradual internal improvements. Finally, the most innovative ceramics made improvements in the dimensions such as

Platform, Process, Relationship and Brand (C2, C3, C1 and C6), while the least innovative were in the Platform, Networks and Processes (C8, C7, C5 and C4).

Before the study, the degree of innovation of the ceramic industries can be measured, and can be visualized through the graphs, which ceramics and which dimensions have the highest degree of innovation. Through this, it is found that some innovative strategies have been implemented by these industries, and it is possible to use this study as a tool of knowledge about which types of innovations are being more adopted in recent years, and in which dimensions the industries are not innovating, enabling the construction of new strategies.

As a theoretical contribution, it was possible to expand the knowledge on the topic, considering that no research related to the analysis of innovation in the ceramic industry was identified. For future studies, it is suggested the investigation of the method in other regions of ceramic industrial pole so that one can have a broader view on the innovative level of this sector, base for important activities of the national economy.

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