INCREMENTAL AND RADICAL INNOVATIONS IN MICRO AND SMALL ENTERPRISES: EVIDENCE FROM THE ALI PROGRAM IN PERNAMBUCO

INOVAÇÕES INCREMENTAIS E RADICAIS EM MICRO E PEQUENAS EMPRESAS: EVIDÊNCIAS DO PROGRAMA ALI EM PERNAMBUCO

INNOVACIONES INCREMENTALES Y RADICALES EN MICRO Y PEQUEÑAS EMPRESAS: EVIDENCIA DEL PROGRAMA ALI EN PERNAMBUCO

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Marcos Roberto Gois de Oliveira Macedo[1]

ABSTRACT

This article analyzes the impacts of technological and managerial innovations — classified as incremental or radical — on the productivity and survival capacity of micro and small enterprises (MSEs), based on the experience of the ALI (Local Innovation Agents) Program in Pernambuco, Brazil. Given the growing need for innovation strategies tailored to the profile of MSEs, an analytical model was proposed based on the adaptation of the Sectoral Innovation Degree (GIS), which led to the creation of the Incremental Innovation Degree (G^2I). The study evaluated 48 companies using the Sebrae Innovation Radar, classifying 18 themes into technological and managerial axes according to their diffusion in the sector. The results show that approximately half of the indicators analyzed represent radical innovations, highlighting an untapped potential for disruptive practices. The G^2I model proved to be a useful tool for diagnosing innovation maturity, guiding the prioritization of strategies, and supporting public innovation policies based on empirical and contextualized evidence.

Keywords: Radical Innovation. Incremental Innovation. Sectoral Innovation Degree. Micro and Small Enterprises. ALI Program.

RESUMO

Este artigo analisa os impactos das inovações tecnológicas e gerenciais — classificadas como incrementais ou radicais — sobre a produtividade e a capacidade de sobrevivência de micro e pequenas empresas (MPEs), a partir da experiência do Programa ALI (Agentes Locais de Inovação) em Pernambuco. Diante da crescente demanda por estratégias de inovação adaptadas ao perfil das MPEs, foi proposto um modelo analítico baseado na adaptação do Grau de Inovação Setorial (GIS), que deu origem ao Grau de Inovação Incremental (G^2I). A pesquisa avaliou 48 empresas por meio do Radar de Inovação do Sebrae, classificando 18 temas em eixos tecnológicos e gerenciais, conforme sua difusão no setor. Os resultados revelam que aproximadamente metade dos indicadores analisados representa inovações radicais, o que evidencia um potencial subexplorado para práticas de ruptura. O modelo G^2I demonstrou ser um instrumento útil para diagnosticar a maturidade

[1] Dr. in Economics. Universidade Federal de Pernambuco. E-mail: marcos.gois@ufpe.br
Orcid: https://orcid.org/0000-0002-1405-0311 Lattes: https://lattes.cnpq.br/0923894876849625

inovativa das empresas, orientar a priorização de estratégias e subsidiar políticas públicas de estímulo à inovação com base empírica e contextualizada.

Palavras-chave: Inovação Radical. Inovação Incremental. Grau de Inovação Setorial. Micro e Pequenas Empresas. Programa ALI.

RESUMEN
Este artículo analiza los impactos de las innovaciones tecnológicas y gerenciales — clasificadas como incrementales o radicales— sobre la productividad y la capacidad de supervivencia de las micro y pequeñas empresas (MYPE), a partir de la experiencia del Programa ALI (Agentes Locales de Innovación) en Pernambuco, Brasil. Ante la creciente necesidad de estrategias de innovación adaptadas al perfil de las MYPE, se propuso un modelo analítico basado en la adaptación del Grado de Innovación Sectorial (GIS), que dio origen al Grado de Innovación Incremental (G²I). El estudio evaluó 48 empresas mediante el Radar de Innovación de Sebrae, clasificando 18 temas en ejes tecnológicos y gerenciales según su nivel de difusión en el sector. Los resultados revelan que aproximadamente la mitad de los indicadores analizados representan innovaciones radicales, lo que evidencia un potencial subutilizado para prácticas disruptivas. El modelo G²I demostró ser una herramienta útil para diagnosticar la madurez innovadora de las empresas, orientar la priorización de estrategias y respaldar políticas públicas de innovación basadas en evidencia empírica y contextualizada.

Palabras clave: Innovación Radical. Innovación Incremental. Grado de Innovación Sectorial. Micro y Pequeñas Empresas. Programa ALI.

1 INTRODUCTION

Innovation is widely recognized as an essential factor for the competitiveness and sustainability of companies, regardless of their size (Santos, 2020; Rajapathirana & Hui, 2018). However, micro and small enterprises (MSEs) face specific challenges to identify, absorb and apply innovative practices that are aligned with their stage of maturity and management capacity. In this context, it becomes crucial to distinguish between incremental innovations—which improve existing practices—and radical innovations—which represent significant disruptions in organizational or technological models.

The literature on organizational innovation has evolved from a unitary approach to a dichotomous view, recognizing different types and intensities of innovation (Dewar & Dutton, 1986; Lennerts et al., 2020; Johnson, 2020). Despite this theoretical evolution, there is still a gap in the empirical operationalization of indicators that allow objectively classifying the type of innovation implemented in MSEs, especially in the context of public programs to foster innovation.

In addition, although there are several studies on innovation in micro and small companies, most adopt descriptive, qualitative or subjective perception-based approaches, without advancing in the objective measurement of the type of innovation implemented (Demircioglu & Audretsch, 2017; Kato-Vidal, 2019; Valladares et al., 2014). Previous research on the ALI Program, for example, has highlighted advances in innovative practices (Nogueira et al., 2017; Silva et al., 2018), but did not deepen the differentiation between incremental and radical innovations based on empirical and sectoral criteria. There are still few models that integrate consolidated diagnostic tools with quantitative metrics capable of guiding the strategic planning of MSEs according to their innovative maturity (Oliveira et al., 2014; Novais, 2024). In this sense, this work contributes by proposing a replicable and reasoned methodology that advances the understanding of the innovative behavior of these companies, filling a relevant gap in the national literature.

This study proposes a quantitative methodology to classify and analyze incremental and radical innovations in MSEs, based on the adaptation of the Sector Innovation Degree (GIS), originally developed by Oliveira et al. (2011). The approach was applied to 48 companies participating in the ALI Program (Local Innovation Agents), promoted by Sebrae-PE in 2022. The classification of innovations is based on the application of the Innovation Radar, a diagnostic tool that evaluates maturity in 18 topics related to management and innovation.

The main contribution of this study lies in the proposition and application of the Incremental Innovation Degree (G^2I), a quantitative indicator derived from the Sectoral

Innovation Degree (GIS), adapted to the context of micro and small enterprises. This metric makes it possible to distinguish, on an empirical and sectoral basis, which innovative practices are considered incremental — widely disseminated and accessible — and which are configured as radical, as they require greater capacity for organizational or technological disruption. This is an important methodological advance compared to the more qualitative or generic approaches predominant in the literature.

In addition, G²I enables an individualized diagnosis of the innovative maturity of companies, functioning as an instrument to support strategic decision-making, both for MSE managers and for development agents and public policy makers. By integrating consolidated diagnostic tools (such as the ALI Radar) with an objective and scalable analytical logic, the study contributes to the construction of an operational framework that qualifies the process of prioritizing actions in environments with low installed capacity for innovation. This approach can be replicated in different sectoral and territorial contexts, expanding its potential for impact in the formulation of strategies aligned with the reality of Brazilian MSEs.

2 THEORETICAL FRAMEWORK

The advancement of discussions on innovation in MSEs demands an integrated theoretical approach, articulating different dimensions of innovation as a study phenomenon. In this context, this theoretical framework is structured in such a way as to contemplate three complementary axes. Initially, the relationship between innovation and productivity from the technological and managerial perspectives is discussed. Then, the distinction between incremental and radical innovations is deepened, highlighting their theoretical and operational implications. Finally, empirical studies related to the ALI Program, the database used, are presented, with the objective of positioning the present research within the scope of the existing literature and evidencing its contribution and limitations.

2.1 PRODUCTIVITY AND INNOVATION: MANAGERIAL AND TECHNOLOGICAL PERSPECTIVES

The relationship between innovation and productivity is one of the pillars of the economic and organizational literature, and is central to understanding the competitive performance of companies. This debate gains special relevance from Solow's Paradox, which evidences the apparent dissociation between technological advances and effective productivity gains, observed especially from the 1970s onwards in developed economies (TEIXEIRA, 2001).

In the context of this paradox, Macedo et al. (2024) argue that the gap between technological adoption and performance can be explained by the absence of organizational mechanisms capable of converting innovation into concrete results, especially in environments with structural constraints, as is the case of micro and small enterprises (MSEs). Empirical evidence from the study applied to the context of Pernambuco indicates that exogenous managerial innovation — such as that promoted by institutional programs — has a positive impact on the probability of productivity gains, significantly increasing the expected performance of these organizations.

This interpretation shifts the understanding of the paradox from a supposed limitation of technology to a problem related to the diffusion, assimilation, and complementarity between different types of innovation. Corroborating this perspective, recent studies show that innovations in products, processes, and technologies have a positive impact on the performance of firms, both in isolation and in an integrated way (MULOLLI et al., 2024). However, in the case of MSEs, this relationship takes on specific contours, since structural limitations, resource constraints, and organizational capacities condition the way innovations are incorporated and transformed into efficiency gains (GARRIDO-PRADA et al., 2024; ZHANG, 2025).

From this debate, the literature began to be structured in two main analytical approaches: macroeconomic and microeconomic (AUDRETSCH; BELITSKI, 2020). At the macroeconomic level, studies investigate the aggregate effects of innovation on the economic performance of countries, with an emphasis on technological diffusion and institutional capacity (GRIFFITH et al., 2006; DE NEGRI et al., 2021). On the other hand, the microeconomic approach focuses on the firm level, analyzing how organizational characteristics, business strategies, and internal capabilities influence productivity generation, both in developed and developing economies (MOHNEN et al., 2018; ROPER et al., 2017; NASSIF et al., 2017).

In general, these approaches converge in indicating that the simple adoption of technologies does not guarantee productivity gains, and that it is necessary to articulate them with innovations of a managerial nature. In this sense, recent literature emphasizes that productivity results from the interaction between technological innovation and organizational innovation, especially in contexts of resource constraints, as is the case of MSEs (ASAME et al., 2025). In addition, it is argued that saturation of incremental improvements can reduce the marginal impact of innovation on performance, reinforcing the importance of more disruptive strategies to sustain gains over time.

Thus, as argued by Macedo et al. (2024), overcoming the paradox depends on the integration between technological and managerial innovation, as well as on the ability of organizations to internalize and explore these complementarities. Although the literature recognizes the importance of innovation for productivity, this relationship is not homogeneous, varying according to the nature and intensity of the innovations implemented. In this sense, it is essential to distinguish different types of innovation, especially with regard to incremental and radical innovations, a topic that will be deepened in the next subsection.

2.2 INCREMENTAL AND RADICAL INNOVATION: CONCEPTS, DISTINCTIONS AND ANALYTICAL IMPLICATIONS

The distinction between incremental innovation and radical innovation is one of the central axes of the innovation management literature, allowing us to understand not only the degree of novelty of the changes implemented, but also their impacts on organizational performance. Since the classic studies of Dewar and Dutton (1986), this differentiation has been used to explain variations in the results of innovation, especially in terms of risk, complexity, and potential return.

Traditionally, this distinction has been strongly associated with the technological dimension, being defined from the level of disruption in products and processes (CHANDY; TELLIS, 1998; LENNERTS et al., 2020). However, more recent studies indicate that this classification is less objective than it seems, since different approaches use different criteria to characterize the degree of novelty, which generates conceptual ambiguities and difficulties in empirical measurement (KUSIAK, 2023; SI et al., 2022).

In this context, the Oslo Manual consolidates a multidimensional view of innovation, classifying it into four main categories: product, process, organizational, and marketing. This typology reinforces that innovation is not limited to the introduction of new technologies, but also involves transformations in the way organizations structure their activities, manage resources, and position themselves in the market.

Based on this expanded perspective, incremental innovation can be understood as the introduction of gradual improvements in products, processes or organizational practices, based on the recombination or adaptation of existing and widely disseminated knowledge in the sector. This type of innovation tends to present a lower degree of uncertainty and risk, being particularly relevant for companies with resource constraints, such as micro and small enterprises (MSEs), as it allows progressive gains in efficiency and competitiveness.

On the other hand, radical innovation refers to the introduction of substantial changes that imply a break with established practices, often associated with the incorporation of new knowledge, technologies or business models that are still not widespread in the market. These innovations have the potential to redefine technological and organizational trajectories, creating new frontiers of performance and competitive advantage (SHENG; CHIEN, 2016).

However, the distinction between incremental and radical innovation should not be understood as dichotomous, but rather as a continuum, in which different innovative practices can present varying degrees of novelty and impact. This perspective is particularly relevant in the context of MSEs, in which decisions related to innovation involve trade-offs between risk, cost and implementation capacity, and are often conditioned by structural limitations and low absorptive capacity.

In view of this, an important gap in the literature emerges: the difficulty of objectively operationalizing the distinction between incremental and radical innovation in empirical contexts. Several studies have sought to address this challenge through different measurement strategies. For example, classical approaches use the degree of perceived novelty in relation to the market or the firm as a classification criterion (DEWAR; DUTTON, 1986; CHANDY; TELLIS, 1998), while other studies adopt indicators based on technological intensity, investments in R&D or the introduction of new products (OECD, 2018; MOHNEN et al., 2018). There are also attempts at measurement based on surveys and managerial self-assessment, such as those derived from the use of the Innovation Radar and similar instruments applied in small companies.

However, these approaches have significant limitations. Perception-based measures tend to introduce subjective biases and difficulties in comparability between companies and sectors. Indicators based on R&D or technological intensity, in turn, are poorly suited for micro and small companies, which often innovate without formal structured investments. Survey-based instruments, on the other hand, face problems of standardization and methodological consistency, especially in heterogeneous contexts. As recent studies highlight, there is no consensus in the literature regarding the operational criteria that define the degree of novelty of an innovation, which compromises the comparability of empirical results (KUSIAK, 2023; SI et al., 2022; CROSSAN; APAYDIN, 2010).

In addition, contemporary systematic reviews point out that the absence of standardized metrics to classify innovations as incremental or radical constitutes one of the main limitations of the field, hindering both the replicability of studies and their practical application in public policies and business management (GARCÍA-SÁNCHEZ et al., 2024; DEMIRCIoglu;

AUDRETSCH, 2017). This gap is even more critical in the context of MSEs, where innovation occurs in a diffuse, informal and strongly dependent way

It is in this context that the proposal of this study is inserted, by introducing the Degree of Incremental Innovation (G²I) as a quantitative indicator capable of classifying innovative practices based on their sectoral diffusion. Considering that widely disseminated practices tend to reflect incremental innovations, while less widespread practices indicate a greater degree of novelty and disruptive potential, the proposed model allows for the operationalization, in an objective and comparable way, of the distinction between incremental and radical innovation. In this way, G²I contributes to overcoming methodological limitations in the literature, offering an approach applicable to the context of MSEs and aligned with the need for empirical measurement of innovation.

2.3 EMPIRICAL STUDIES ON INNOVATION IN MSES AND THE ALI PROGRAM

The empirical literature on innovation in micro and small companies has been strengthened by studies applied to institutional development programs, such as the Local Innovation Agents Program (ALI), coordinated by Sebrae. In general, these surveys use diagnostic instruments, such as the Innovation Radar, to assess the innovative maturity of companies in different dimensions.

Studies carried out in different regional contexts show that the program contributes to the adoption of innovative practices and improvement of organizational performance (NOGUEIRA et al., 2017; VIRGENS et al., 2016; SILVA et al., 2018). However, most of these investigations adopt descriptive or qualitative approaches, focusing on the evolution of innovation indicators, without advancing in the distinction between different types of innovation implemented.

In this sense, there is a gap in the literature regarding the use of metrics capable of objectively classifying innovations in terms of their degree of novelty or rupture. The present study advances in this field by proposing the Incremental Innovation Degree (G²I), allowing the differentiation of innovative practices based on their sectoral diffusion and contributing to a more accurate analysis of the nature of innovation in MSEs.

3 METHODOLOGY

This research adopts a quantitative, descriptive and analytical approach, with the objective of classifying and analyzing the nature of innovations implemented by micro and small enterprises (MSEs), distinguishing between incremental and radical practices based on a model based on empirical data.

3.1 POPULATION AND DATA SOURCE

The study population is composed of 48 micro and small companies participating in the 4th edition of the Local Innovation Agents Program (ALI), conducted by Sebrae-PE in 2022, in the Metropolitan Region of Recife. The companies are distributed in the sectors of commerce (22), industry (11) and services (15), reflecting the structural diversity of the universe of small businesses served by the program.

The data were obtained with authorization from the state coordination of the program, and came from the application of the diagnostic instrument called Innovation Radar. The ALI Program aims to stimulate innovation and increase productivity in small businesses through the performance of trained agents, who accompany companies throughout structured intervention cycles.

The Innovation Radar is the main methodological tool of the program, allowing the evaluation of the innovative maturity of companies in six dimensions: Management by Indicators, Sustainable Practices, Operations Management, Innovation, Marketing and Digital Transformation. Each dimension is subdivided into three themes, totaling 18 indicators evaluated, which enables a multidimensional analysis of innovation capacity.

3.2 DATA COLLECTION INSTRUMENT: THE ALI RADAR

Data collection was carried out through the application of the ALI Radar by trained local innovation agents, following a standardized protocol. For each of the 18 topics evaluated, a score was assigned based on an ordinal scale of five maturity levels, according to criteria established by Sebrae (2020).

This instrument allows measuring the company's stage of development in different dimensions of innovation, providing a structured and comparable basis for analysis. The standardization of the application process and the training of agents contribute to the consistency and reliability of the data collected.

3.3 CLASSIFICATION OF THEMES INTO TECHNOLOGICAL AND MANAGERIAL AXES

The 18 themes of the Innovation Radar were classified into two analytical axes: technological innovation and managerial innovation. This categorization was carried out based on the predominant nature of each theme, distinguishing practices related to the adoption of technologies and operational processes from those associated with management, organizational culture and decision-making.

This distinction allows analyzing not only the level of innovation of companies, but also the predominance of different types of innovation, contributing to the understanding of the relationship between technological innovation, managerial innovation and organizational performance.

3.4 CONSTRUCTION OF THE INCREMENTAL INNOVATION DEGREE (G²I)

To assess the nature of the innovations implemented, this study adapts the Sector Innovation Degree (GIS) model, originally proposed by Oliveira et al. (2014), based on the innovation frontier logic inspired by Sawhney et al. (2006).

Consider a set of companies and dimensions (or themes) of innovation evaluated by the ALI Radar. Let the score assigned to the company in the dimension , with and .$n\ KD_{ik} \in [0,5]iki = 1, \dots, nk = 1, \dots, K$

The company's Incremental Innovation Degree is defined as:i

$$G^2I_i = \sum_{k=1}^{K} p_k\, D_{ik} \quad (1)$$

where represents the weight associated with the dimension, subject to the restriction: $p_k \geq 0k \sum_{k=1}^{K} p_k = 1$

The weights are estimated from an optimization problem that seeks to maximize the average degree of incremental innovation in the set of companies, as follows:p_k

$$\max_{p_k} \left(\frac{1}{n} \sum_{i=1}^{n} \sum_{k=1}^{K} p_k\, D_{ik} \right) \quad (2)$$

subject to: $\sum_{k=1}^{K} p_k = 1 e p_k \geq 0, \forall k$

This formulation implies that more widespread dimensions among companies — that is, those with a higher average contribution — tend to receive greater weight, being characterized as **incremental innovations**. On the other hand, dimensions that do not contribute to the maximization of the objective function (i.e., with) are interpreted as $p_k = 0$**radical innovations**, as they reflect practices that are not widely disseminated in the sector.

In addition, the Degree of Sectoral Incremental Innovation (G²IS) is defined as:

$$G^2IS = \frac{1}{n}\sum_{i=1}^{n} G^2\, I_i \quad (3)$$

This approach allows interpreting G²I as a relative and endogenous measure of the structure of the sector analyzed, capturing the degree of diffusion of innovative practices and enabling the empirical distinction between incremental and radical innovation.

3.5 INTEGRATION WITH THE ALI PROGRAM AND DATA VALIDITY

The link to the ALI Program reinforces the robustness of the methodology adopted, since the Innovation Radar provides structured, comparable data directly associated with the interventions carried out in the companies. The actions developed by the agents aim to strengthen the absorptive capacity of entrepreneurs, according to the concept of Cohen and Levinthal (1990), expanding the ability of companies to recognize, assimilate and apply new knowledge.

In addition, the assisted application of the instrument, combined with the continuous monitoring of companies, contributes to the reduction of measurement biases and increases the reliability of the data. In this way, the institutional environment of the program acts as a methodological mediator, ensuring greater consistency in the collection and interpretation of information.

3.6 METHODOLOGICAL LIMITATIONS

Despite the consistency of the proposed model, some limitations must be considered. First, the sample is restricted to companies participating in the ALI Program in a specific region, which may limit the generalization of the results to other territorial or sectoral contexts.

In addition, the data used come from a diagnostic instrument applied by external agents, which, although standardized, may incorporate biases associated with the evaluators' interpretation and the degree of interaction with the entrepreneurs.

Another relevant point refers to the very nature of the G²I model, which classifies innovations based on their relative diffusion in the analyzed set. Thus, the characterization of an innovation as incremental or radical depends on the empirical context considered, not being an absolute classification, but rather relational and dependent on the structure of the sector.

Finally, it is noteworthy that the model does not directly incorporate external variables, such as market conditions or financial performance, which opens space for future investigations that integrate G²I into more comprehensive explanatory models.

4 RESULTS

The analysis of the data obtained from the application of the Innovation Radar allowed the identification of relevant patterns regarding the nature of innovations — technological and managerial — in micro and small companies in the Metropolitan Region of Recife. The results are presented from the logic of the Incremental Innovation Degree (G^2I), which allows empirically distinguishing incremental and radical practices based on their diffusion in the analyzed set.

4.1 CLASSIFICATION OF INNOVATION THEMES

Chart 1 presents the 18 themes evaluated, classified according to their nature (technological or managerial) and the type of innovation (incremental or radical), according to the weights estimated in the G^2I model.

In general, there is a relatively balanced distribution between incremental and radical innovations. However, the analysis of the data reveals that incremental innovations are associated with themes with higher average and lower dispersion, indicating wide diffusion among companies. Among these practices are management by indicators, monitoring, pricing, and customer satisfaction.

On the other hand, innovations classified as radical have lower averages and greater variability, showing that their adoption is not homogeneous and depends on specific capabilities of companies. Themes such as culture of innovation, product innovation, digitalization and digital presence stand out in this group, revealing relevant structural gaps in the innovative behavior of MSEs.

Table 1

Classification of sectors according to type of innovation

		Inovação Gerencial ou Tecnológica?	Inovação Incremental ou de Ruptura?		
Dimensão	Temas		Comercio	Indústria	Serviço
Gestão por indicadores	Indicadores Chave	Gerencial	Incremental	Incremental	Incremental
	Estabelecimento de Metas	Gerencial	Incremental	Radical	Incremental
	Monitoramento	Gerencial	Incremental	Incremental	Incremental
Gestão das operações	Operação Enxuta	Tecnológica	Incremental	Incremental	Incremental
	Gestão por Processos	Tecnológica	Incremental	Incremental	Incremental
	Cultura de Alta Performance	Tecnológica	Radical	Incremental	Radical
Marketing	Satisfação do Cliente	Gerencial	Incremental	Incremental	Incremental
	Formação de Preços	Gerencial	Incremental	Incremental	Incremental
	Publicidade	Gerencial	Incremental	Radical	Incremental
Práticas sustentáveis	Gestão de Energia	Tecnológica	Radical	Radical	Radical
	Gestão de Água	Tecnológica	Radical	Radical	Radical
	Redução de Desperdício	Tecnológica	Incremental	Incremental	Incremental
Inovação	Inovação de Processos	Tecnológica	Incremental	Incremental	Incremental
	Inovação de Produtos e Serviços	Tecnológica	Radical	Radical	Radical
	Cultura da Inovação	Gerencial	Radical	Radical	Radical
Transformação digital	Digitalização Interna	Gerencial	Radical	Radical	Radical
	Presença Digital	Gerencial	Radical	Radical	Radical
	Meios Eletrônicos de Pagamentos	Gerencial	Radical	Radical	Radical

Source: Prepared by the authors.

This result reinforces the consistency of the G²I model by showing that sectoral diffusion is a valid empirical criterion to distinguish different types of innovation.

4.2 SECTORAL BEHAVIOR OF INNOVATIONS

The comparative analysis between the sectors of industry, services and commerce reveals relevant structural differences in the pattern of innovation.

In the industrial sector, greater heterogeneity is observed among the companies, with an arithmetic mean of 2.09 (SD = 0.53) and a weighted average of 2.85 (SD = 0.78). This pattern indicates the coexistence of companies with different levels of innovative maturity, suggesting that innovation relies heavily on internal and structural capabilities.

In the services sector, the results indicate greater homogeneity, with an arithmetic mean of 2.08 (SD = 0.31) and a weighted average of 2.26 (SD = 0.40). This behavior suggests a more uniform pattern of adoption of innovative practices, but with less intensity in the dimensions considered strategic.

The trade sector, on the other hand, has an arithmetic average of 2.14 (SD = 0.31) and a weighted average of 2.30 (SD = 0.35), showing an intermediate level, but with a higher concentration of companies at higher levels of innovation.

Table 2

Descriptive statistics of the sectors analyzed

Industry	Arithmetic Mean	DP	Weighted Average	DP	Average G²I	DP
Industry	2,09	0,53	2,85	0,78	0,85	0,22
Services	2,08	0,31	2,26	0,40	0,89	0,23
Trade	2,14	0,31	2,30	0,35	0,97	0,22

Source: Prepared by the authors

Table 1 shows structural differences between the sectors, highlighting greater dispersion in industry and higher average level of innovation in trade.

In general, the results indicate that innovation does not occur homogeneously across sectors: while industry has greater dispersion and potential for radical innovation, trade shows greater diffusion of innovative practices, and services show intermediate and more homogeneous behavior.

4.3 FRONTIER OF INNOVATION AND TYPOLOGY OF RADICAL INNOVATIONS

The analysis of the mean scores and the dispersion of the themes classified as radical allowed us to identify three distinct patterns of innovative behavior:

(i) Low medium and low dispersion. Topics such as energy management and water management have low levels of adoption and little variability between companies. This pattern indicates a relatively low innovation frontier, suggesting adoption opportunities with low risk and potential for immediate impact.

(ii) Medium high. Topics related to digital transformation have high averages, indicating that its implementation requires deeper structural changes. In this case, radical innovation is associated with a higher degree of complexity and risk.

(iii) Intermediate medium with high dispersion. Topics such as product innovation and innovation culture show high variability among companies, with some already operating at advanced levels. This pattern suggests an environment conducive to the

dissemination of knowledge among peers, with potential for learning and replication of good practices.

4.4 DEGREE OF INCREMENTAL INNOVATION (G²I) OF COMPANIES

Table 3 presents the G²I values for the companies analyzed, allowing the level of innovative maturity to be evaluated individually.

Table 3

Degree of Incremental Innovation (G²I) of companies by sector

Company	Commerce	Industry	Service	Company	Commerce	Service
Company 01	**1,1**	**1,1**	**1,1**	Company 12	**1,1**	**1,1**
Company 02	**0,7**	**0,7**	**0,7**	Enterprise 13	**1,1**	**1,1**
Company 03	**0,8**	**0,8**	**0,8**	Company 14	**0,7**	**0,7**
Company 04	**0,9**	**0,9**	**0,9**	Company 15	**1,2**	**1,2**
Company 05	**0,6**	**0,6**	**0,6**	Company 16	**1,2**	
Company 06	**0,6**	**0,6**	**0,6**	Company 17	**1,2**	
Company 07	**0,6**	**0,6**	**0,6**	Enterprise 18	**1,2**	
Company 08	**0,8**	**0,8**	**0,8**	Company 19	**1,2**	
Company 09	**1,1**	**1,1**	**1,1**	Enterprise 20	**1,1**	
Enterprise 10	**0,9**	**0,9**	**0,9**	Enterprise 21	**1,1**	
Enterprise 11	**1,2**	**1,2**	**1,2**	Enterprise 22	**0,9**	

Source: Prepared by the authors based on the calculation of G²I

Based on the results, it is observed that there are three distinct profiles of companies:

Low G²I (≤ 0.7): companies with low innovative maturity, for which prioritizing incremental innovations is more appropriate, due to lower risk and greater ease of implementation.

Intermediate G²I (0.8 – 1.0): companies in transition, with the potential to gradually move towards more sophisticated practices.

High G²I (≥ 1.1): companies with greater innovative capacity, able to implement radical innovations and explore opportunities for greater competitive impact.

This segmentation reinforces the applied character of the G²I model, allowing differentiated innovation strategies to be guided according to the stage of maturity of the companies.

The analysis of specific cases reinforces the practical applicability of the model. Companies with high G²I have a greater capacity to incorporate more sophisticated managerial and technological practices, while companies with low G²I tend to focus efforts on incremental improvements of less complexity.

These results show that G²I can be used as an instrument to support decision making, allowing to guide innovation strategies according to the stage of maturity of the companies.

5 DISCUSSION

The results obtained in this study allow us to advance in the understanding of the nature of innovation in micro and small enterprises (MSEs), especially by integrating empirical evidence with the theoretical debate on incremental and radical innovation. In general, the findings reinforce the idea that innovation in MSEs occurs in a heterogeneous way, being strongly conditioned by structural, organizational and sectoral factors.

First, the identification that incremental innovations are concentrated in widely disseminated managerial and operational practices — such as monitoring, process management, and pricing — corroborates the literature that highlights the role of incremental innovation as the main mechanism of adaptation in resource-constrained environments. This result is consistent with studies indicating that MSEs tend to prioritize low-risk continuous improvements, to the detriment of more disruptive innovations.

On the other hand, the finding that dimensions associated with technological and strategic innovation — such as digitalization, culture of innovation and development of new products — remain not widespread highlights the existence of a structural gap in the innovative behavior of these companies. This finding dialogues directly with the literature on limitations of absorptive capacity in MSEs, suggesting that the difficulty is not in the availability of innovative solutions, but in the ability to assimilate and implement these practices.

In this sense, the results contribute to reinterpret Solow's Paradox in the context of MSEs. Rather than indicating an inefficiency of the technology, the data suggest that the limitation lies in the low diffusion and complementarity between technological and managerial innovation. Thus, the absence of significant productivity gains can be explained by the predominance of incremental innovations and the low incorporation of more disruptive practices.

The comparative analysis between sectors reinforces this interpretation. The industry showed greater dispersion in the indicators, evidencing the coexistence of companies at different stages of innovative maturity, which suggests greater potential for radical innovation, albeit unevenly. On the other hand, the services and trade sectors showed greater homogeneity, with emphasis on trade, which had a higher average of G²I, indicating a greater diffusion of innovative practices.

This industry pattern suggests that innovation in MSEs is not only a function of the internal capabilities of companies, but also of the competitive environment and characteristics of the sector in which they operate. While more structured sectors can favor the emergence of more complex innovations, more dynamic and market-oriented sectors tend to stimulate the diffusion of incremental practices.

Additionally, the typology proposed from the analysis of the mean and dispersion of the themes contributes to the conceptual advancement of the literature by demonstrating that radical innovation is not a homogeneous phenomenon, but presents different patterns of diffusion and complexity. The identification of topics with high dispersion indicates the existence of "islands of excellence", in which some companies already operate at advanced levels of innovation, creating opportunities for learning and dissemination for the rest of the sector.

Finally, the results show the robustness of the G²I model as an analytical instrument. By classifying innovations based on their sectoral diffusion, the model overcomes limitations of subjective approaches or those based exclusively on technological intensity, offering an objective and contextualized metric. This characteristic expands its applicability both for academic purposes and for practical use in innovation support programs.

6 CONCLUSION

This study aimed to analyze the nature of innovations in micro and small companies, distinguishing between incremental and radical practices from a quantitative approach based on the Incremental Innovation Degree (G²I). From the application of the model to companies participating in the ALI Program in Pernambuco, it was possible to advance in the empirical measurement of innovation, contributing to overcome a relevant gap in the literature.

The results show that innovation in MSEs is predominantly incremental, concentrating on widely disseminated managerial and operational practices. On the other hand, radical innovations, associated with technological and strategic transformations, have a lower level of diffusion, indicating a potential that is still little explored.

The sectoral analysis revealed that innovative behavior varies significantly between industry, services and commerce. While industry presents greater heterogeneity and potential for radical innovation, trade demonstrates greater diffusion of innovative practices, and services present an intermediate and more homogeneous pattern. These results reinforce the importance of considering the sectoral context in the formulation of innovation strategies.

From a theoretical point of view, the study contributes by proposing and validating the G²I model as a tool capable of operationalizing the distinction between incremental and radical innovation in an objective and data-based way. By using sectoral diffusion as a classification criterion, the model offers an alternative to traditional approaches, often limited by subjectivity or inadequacy to the context of MSEs.

In practical terms, the results indicate that innovation strategies must be aligned with the maturity level of companies. For organizations with low G²I, it is recommended to prioritize

incremental innovations, with a focus on operational and managerial improvements. Companies with greater maturity, on the other hand, can move on to more complex innovations, exploring opportunities for differentiation and competitive advantage.

In addition, the findings suggest that public policies and development programs, such as the ALI, should act not only in the promotion of innovation, but also in the expansion of the absorptive capacity of companies, favoring the diffusion and internalization of more advanced practices.

Finally, limitations related to the scope of the sample and the relational nature of the model are recognized, which opens space for future research. Further studies can explore the application of G²I in different regional and sectoral contexts, as well as its integration with economic performance indicators, expanding the understanding of the relationship between innovation and productivity.

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