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STATISTICAL LITERACY: A BRIDGE BETWEEN ACADEMIC LEARNING AND PRACTICE

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ABSTRACT

Statistical education is becoming increasingly relevant in the digital age, marked by data-driven decision-making. However, it still faces persistent challenges. Research conducted by the Program for the International Assessment of Adult Competencies (PIAAC) and the Program for International Student Assessment (PISA) highlights the difficulties many adults face in interpreting statistical data. This article on statistical education in higher education is based on a survey that analyzed the perceptions of professionals from the Sorocaba Metropolitan Region about the implementation and use of statistical knowledge in the professional environment. The study aimed to identify the critical points for implementing and disseminating statistical techniques and thinking in companies, exploring the gap between academic training in statistics and its practical application. The quantitative methodology was based on a structured questionnaire completed by 410 professionals from the region, and the data analysis characterized the companies, represented by the professionals' responses, into three levels of statistical proficiency: beginner, intermediate, and advanced. The results indicate that the main challenges to implementing statistics in companies include the need for data culture and limited statistical competence. It is concluded that the development of statistical literacy can overcome the barriers between available statistical tools and their application in organizations. This study aligns with the perspective of promoting conscious statistical education and is focused on ways to mobilize knowledge in the service of people and their projects.

Keywords: Education; Statistical literacy; Competence.

SUMMARY

Statistical education is becoming increasingly relevant in the digital age, marked by data-driven decision-making. However, it still faces persistent challenges. Research conducted by*Program for the International Assessment of Adult Competencies* (PIAAC) and by*Program for International Student Assessment*(PISA) highlight the

difficulties that many adults face in interpreting statistical data. This article on statistical education in higher education is based on a survey that analyzed the perceptions of professionals from the Sorocaba Metropolitan Region about the implementation and use of statistical knowledge in the professional environment. The study aimed to identify the critical points for the implementation and dissemination of statistical techniques and thinking in companies, exploring the gap between academic training in statistics and its practical application. The quantitative methodology was based on a structured questionnaire answered by 410 professionals from the region, and the data analysis categorized the companies, represented by the professionals' responses, into three levels of statistical proficiency: beginner, intermediate and advanced. The results indicate that the main challenges for the implementation of statistics in companies include the need for a data culture and limited statistical competence. It is concluded that the development of statistical literacy can overcome the barriers between the available statistical tools and their application in organizations. This study is aligned with the perspective of promoting conscious statistical education and is focused on ways to mobilize knowledge in the service of people and their projects.

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1. INTRODUCTION

In the digital age, where data increasingly drives decisions, statistical education plays a fundamental role. Statistics provides essential tools for interpreting large volumes of data and supporting decisions in diverse areas, such as policy formulation and developing knowledgebased societies. In these societies, social and economic progress is driven by intellectual skills and the use of knowledge rather than physical labor (PRODROMOU, 2021; RADERMACHER, 2022; VANCE et al., 2022).

The demand for analytical skills grows as the world becomes more data driven. Myers (2015) points out that this need directly impacts statistics on education, particularly in higher education. In the United States, for example, statistics has been one of the fastest-growing courses in STEM (science, technology, engineering, and mathematics) programs, driven by the demand for skilled professionals in the job market. In Brazil, with the 1996 Education Guidelines and Bases Law (LDB), statistics began to be included in school curricula as part of

the 'Information Processing' theme in the mathematics discipline (BRASIL, 1996). Since then, teachers and researchers have sought to strengthen statistical education (Cazorla, Kataoka, Silva, 2010). However, challenges such as the limited understanding of statistical concepts among university students remain present (BATANERO, 2013).

Assessment programs such as the Program for the International Assessment of Adult Competencies (PIAAC) and the Program for International Student Assessment (PISA) highlight the many adults face when interpreting statistical data, revealing deficiencies in numerical skills (OECD, 2018). A central issue is the gap between theory and practice since many professionals still use only basic statistical techniques in their work, avoiding more advanced methods (HOERL; SNEE, 2010; COLEMAN, 2013).

Recent studies, such as those by ISC2 (2023) and Brauner, Murawski, and Bick (2023), highlight the lack of specific skills for technological sectors, pointing to the need for more practical education aligned with emerging technologies. This underscores the importance of statistical education in preparing professionals to interpret and use data effectively.

This article discusses statistical literacy in the data age, focusing on its practical application. Based on a survey conducted with professionals from the Sorocaba Metropolitan Region, it seeks to identify educational and organizational barriers that limit the use of statistics in companies and proposes pedagogical actions to bridge the gap between theory and practice in higher education.

2 THEORETICAL FOUNDATIONS

This section explores the practical importance of statistics, considering its historical evolution and importance in professional contexts. It reviews the concept of statistical literacy as the knowledge, skills, and pedagogical implications required to train professionals capable of working in a data-driven society.

2.1 THE HISTORICAL EVOLUTION OF STATISTICS AND ITS PRACTICAL RELEVANCE

In the data age, statistics, the science that collects, organizes, analyzes, and interprets data (VIEIRA, 2019), has broad applications ranging from education to biostatistics (MALAGUERRA; MACDONALD, 2016). From its initial use for censuses in ancient societies to its strategic role in Industry 4.0, statistics have evolved as a central tool for social and economic progress (XU et al., 2021; ROSS; MAYNARD, 2021).

Founded on two pillars: statistical techniques and statistical thinking, statistics combines mathematical methods with a conceptual and interpretative approach. The techniques involve mathematical methods for presenting and analyzing data, while statistical thinking encompasses conceptual and interpretative dimensions, highlighting the understanding of the inherent variability in all processes, an indispensable element in strategic decision-making within organizations (KRISHNAMOORTHI, 2010).

In the 20th century, the relevance of statistics in organizations grew, especially with the increase in global competition in the 1980s, when techniques such as Statistical Process Control (SPC) and Six Sigma were used to improve quality and reduce costs (MONTGOMERY, 2010; HOERL; SNEE, 2012). During the industrial revolutions, statistics evolved by incorporating new technologies and production methods. Each stage of the industrial revolution, from automation to digitalization, has emphasized the importance of statistics as a support for process control and innovation. Industry 4.0 and discussions about Industry 5.0 and 6.0 have further expanded their role in strategic decisions (XU et al., 2021; ROSS; MAYNARD, 2021; DUGGAL, 2022).

Throughout these revolutions, statistics have adapted to meet the demands of increasingly automated and computerized production, culminating in the digital age and, more recently, the Data Revolution, where Big Data, the Internet of Things, and Artificial Intelligence redefines the role of statistics in organizations' strategic and operational decisions (HOERL; SNEE; DE VEAUX, 2014, KENETT; ZACKS; AMBERTI, 2014). In this evolving landscape, statistical tools contribute to optimizing processes and developing intelligent solutions (HOERL; SNEE, 2012). Data and statistics have become valuable assets, impacting everything from market dynamics to organizational strategies (HAN, 2021).

Statistics have evolved from a tool for collecting and organizing data into an indispensable science for analyzing complex processes. It has emerged as an academic discipline valued at all levels of education and as a strategic and operational pillar in the corporate world. It can help organizations face the challenges of the digital age and promote sustainable innovation.

2.2 STATISTICS EDUCATION AND THE GAP BETWEEN THEORY AND PRACTICE An example of the importance of statistics in the contemporary world was when the COVID-19 pandemic occurred in 2020, which showed the importance of data and the need to generate qualified information to support decision-making, both by public managers and

families and individuals. Amid the COVID-19 pandemic, the relevance of the knowledge, skills, and abilities required for statistical literacy has intensified, as analyzed by Gal and Geiger (2022). The media's massive presentation of quantitative data, such as infection rates and projections, has highlighted the challenges the public faces in interpreting this information accurately.

As Lopes et al. (2023) pointed out, this growing demand for statistical skills has impacted higher education with an expansion of statistics in curricula, especially in areas such as agronomic sciences, health, engineering, and social sciences, where empirical evidence is central. In Brazil, statistics is mandatory in several training areas, but students still need help achieving a solid understanding of the concepts (BATANERO, 2013). This highlights the need for teaching methods that integrate practice with theoretical concepts.

Gal and Ograjensek (2017) and Watson (2006) observe the gap between classroom theory and its application. Although statistics are essential for everyday life and the workplace, university teaching tends to emphasize theoretical aspects, with little attention to the practical skills professionals will need. This gap makes applying more advanced statistical methods in everyday professional life difficult, leading many graduates to use more straightforward and limited techniques (SIMICEVIC, 2007; BJERKE; HERSLETH, 2001). In addition, the lack of statistical competence in organizations and insufficient management support compromises the implementation of statistical tools (AHMED; HASSAN, 2003; MAKRYMICHALOS*et al.*, 2005).

Hijazi, Saeed, and Alfaki (2019) point out that although efforts have been made to map the knowledge and skills that statisticians need, a gap persists between university education and the demands of the job market, where more contextualized and applied skills are required.

Gal and Ograjensek (2017) argue that an excessive focus on academic theory limits professionals' ability to interpret and communicate data without developing critical communication skills. This mismatch restricts their performance in areas such as public policy and strategic analysis, where the ability to deal with official statistics is fundamental.

Another relevant point is Gerhart, Rastegari, and Cole's (2024) study, which identifies a need for more alignment between the skills considered necessary by business schools and industry. This results in varied curricula, in which some programs emphasize statistical techniques while others focus on technological tools. In addition, the authors report that courses at top business schools only sometimes include topics such as data visualization and programming, which are in high demand in the job market.

These discrepancies between academic training and market demands show the need to reformulate curricula and incorporate more practice with accurate data, technological skills, and critical and communication skills training. In this way, students would be better prepared to face challenges in both their professional and personal lives (BATANERO, 2013; GAL, 2021; CHRISTENSEN, 2019; HIJAZI; SAEED; ALFAKI, 2019; RADERMACHER, 2021; RIDGWAY, 2016).

2.3 STATISTICAL LITERACY, PROFESSIONAL PRACTICE, AND PEDAGOGICAL IMPLICATIONS

Statistical literacy in statistics education has been the subject of debate and redefinition. With the advancement of Big Data, the ability to interpret and use data has become important for the job market. Prodromou (2021) notes that traditional statistical education, with its excessive focus on theory, no longer adequately prepares citizens to deal with the complexity of contemporary data. The author argues that statistical literacy needs to go beyond the straightforward interpretation of graphs and tables, encompassing critical skills such as the analysis of statistical inferences, communication skills, and an ethical view of the use of large volumes of data.

Statistical literacy encompasses the skills, attitudes, and knowledge needed to solve problems, face challenges, and conduct activities efficiently and ethically in the information age. It involves identifying and reasoning information and statements related to data (GAL, 2002). Statistical literacy is fundamental for survival in today's age, in addition to the traditional skills of reading, writing, and arithmetic (YUN, SWASTIKA, 2018). This evolving concept reflects the growing importance of statistics in a data-driven society. Gal (2021) explains that statistical literacy is not restricted to numerical manipulation but involves a set of skills that allow statistical information to be interpreted, analyzed, and critically reflected upon. This process ranges from data collection and processing to the ethical interpretation of results (CAZORLA; GIORDANO, 2021).

Gal (2021) discusses statistical literacy as a construction with two components: cognitive, which involves reading and interpreting data; mathematical and statistical knowledge; and the ability to question information critically; and dispositional, which refers to beliefs, attitudes, and critical attitudes when analyzing statistical information.

In the professional context, statistical literacy requires critical skills beyond technical mastery. Best (2004) points out that statistics are not neutral; their interpretation depends on choices such as the use of mean or media, the context in which the data is applied, and an

understanding of the variables involved. This way, how data is presented shapes public understanding and impacts professional decisions.

Complementing this view, Gould (2017) suggests that, in addition to interpreting statistics, professionals should be able to collect and manipulate data, understand issues of privacy, and meaningfully represent information. Petocz, Reid, and Gal (2018) reinforce the need to train professionals capable of questioning data quality, identifying biases and understanding the limitations of conclusions, avoiding wrong decisions, and promoting responsible and efficient action. This reality demands a reformulation of statistical teaching methods and content, enabling students to act competently in modern society.

According to Petocz, Reid, and Gal (2018), research into teaching methods that prepare students for professional practice in the data age is needed. The authors suggest that interdisciplinary research and collaboration between educators and market professionals are vital to aligning statistical training with market demands.

The PPDAC cycle (Problem, Planning, Data, Analysis, and Conclusion), developed by Wild and Pfannkuch (1999), offers a practical framework for developing statistical literacy in authentic contexts. Adaptable to different skill and knowledge levels, PPDAC allows databased decisions to be made without the need for complex theoretical techniques such as pvalues and confidence intervals. This cycle highlights the importance of an interactive and practical approach to statistical literacy and is implemented in project-based teaching methods (BATANERO, 2013).

Nikiforidou, Lekka, and Pange (2010) emphasize the need for a university statistics education theory, focusing on practical teaching methods that prepare students to analyze and interpret data in authentic contexts. To this end, they highlight three priority areas: incorporating emerging technologies to make teaching more interactive, constantly updating curriculum content to align with market demands, and adopting innovative teaching approaches that encourage critical thinking.

Stoudt, Scotina, and Luebke (2022) propose that statistical education should adapt to the new context, promoting contextualized learning. For practical training, students must solve real problems, work with concrete data, and use computational tools that encourage the practical application of concepts. Giordano (2018) highlights the importance of statistical literacy as a mandatory skill in modern education. He recommends interdisciplinary projects, highlighting the didactic contract as the basis for an approach that favors student autonomy. This contract

modifies the interaction between teacher, student, and knowledge, central elements of Brousseau's Theory of Didactic Situations (TSD) (2007).

The evolution of statistical literacy goes beyond simply understanding graphs and numbers, consolidating it as a fundamental skill for modern life and enabling citizens to interact critically with the world of data around them. By recognizing the importance of practical skills, critical thinking, and an ethical attitude towards data, teaching statistical literacy in higher education should better prepare students to face the challenges of the professional environment.

Following Freire's (1983) ideas, statistical literacy should foster liberating teaching where students actively participate in learning. This critical and dialogical approach transforms MRS statistical literacy into a tool for intellectual autonomy and conscious participation in social and professional contexts, rejecting the "banking education" model, which treats students as mere receptacles for formulas and procedures without context.

2.4 POPULATION DEFINITION - SOROCABA METROPOLITAN REGION

The Metropolitan Region of Sorocaba (MRS), established in 2014, has consolidated itself as one of the main economic hubs in the state of São Paulo. With an estimated population of 2.25 million inhabitants, the region accounts for approximately 4.4% of São Paulo's Gross Domestic Product (GDP). Its strategic location, close to major highways like Raposo Tavares and Castello Branco, facilitates mobility and the flow of goods, benefiting key sectors such as industry, agriculture, and tourism. The MRS comprises 27 municipalities, including Sorocaba, Itu, Votorantim, and Tatuí, and has a diversified economy with a strong presence in the industrial, commercial, and service sectors (INVESTE SÃO PAULO, 2024).

The MRS has an industrial park with over 2,000 factories, highlighting Sorocaba as a significant industrial hub in the state. In addition, commerce and services are essential to the regional economy, with Sorocaba hosting over 70,000 companies of various sizes (CIDADES SUSTENTÁVEIS, 2024). The service sector accounts for 68% of the city's GDP, underscoring its importance for regional economic development (INVESTE SÃO PAULO, 2024).

The region also stands out in the medium- and high-technology industrial sectors, particularly in the metal-mechanical, electronics, healthcare, and biotechnology segments, which contribute significantly to exports and technological innovation (DESENVOLVE SP, 2023). The adoption of advanced technologies strengthens the MRS's position at the forefront of sustainable development and industrial innovation, aspects highlighted in recent studies (RIBEIRO et al., 2020; LEITE; ARAÚJO, 2020).

The creation of the Sorocaba Technology Park, the result of joint action between industries and educational and research institutions, stands out as an initiative to promote innovation and entrepreneurship and foster sustainable growth (AMS, 2022). However, rapid growth and accelerated urbanization impose challenges and demand solutions to urban infrastructure issues and the preservation of socio-environmental heritage. In this sense, the Integrated Urban Development Plan (PDUI), by the Metropolis Statute (Federal Law 13.089/2015), strategically addresses these challenges. By promoting balanced economic development and improving the quality of life in the region, the PDUI aims to align the growth of the MRS with the needs of the labor market, especially in sectors that require professionals trained to deal with advanced technologies and sustainable practices.

Urban and economic efforts highlight the need for education that meets regional demands. Thus, statistical literacy and collaboration between universities and companies are fundamental to ensuring that academic training is aligned with market needs, boosting both sustainable development and the economic dynamism of the MRS.

According to the Higher Education Census 2022, the MRS has 15 higher education institutions (BRAZIL, 2022). These institutions, including universities and public and private colleges, offer a wide range of courses in different areas of knowledge. Sorocaba, the most populous city in the MRS, receives students daily from various regional municipalities, making it stand out as an industrial hub and an essential regional educational center (PIO, 2023).

With a diversified economy and a strong presence in high-tech industries, the MRS faces a growing demand for professionals with the skills and abilities to work in critical sectors such as metalworking, electronics, and agribusiness, which are essential for the region's innovation and competitiveness. In this context, statistical literacy and collaboration between universities and companies ensure academic training aligns with market needs, boosting sustainable development and the MRS's economic dynamism.

3 METHODOLOGY

This study is based on a survey that adopted a quantitative descriptive approach to evaluate the dissemination and effective use of statistical knowledge in companies located in the MRS, chosen because of its economic relevance and representativeness as a regional educational center. A non-probabilistic sample was chosen due to the difficulty of accessing complete lists of organizations in the region, which made random selection impossible.

The method used a survey questionnaire in the form of a six (6) point Likert scale, excluding the neutral position, which requires a careful decision to ensure the quality of the data collected. They defined this number of points without an intermediate option to encourage a more precise choice for respondents between the extremes of the scale. This decision considered factors such as the target audience, the specific objectives of the survey, and the participants' response styles, aiming to improve the data's reliability, validity, and interpretation.

Data collection took place between May and September 2022. To determine the sample size, the factors recommended by Vieira (2019) were considered, such as a 95% confidence level and a 5% margin of error. The expected proportion of 0.5 was adopted without a prior estimate, maximizing the sample size. Equation 1 shows the formula for calculating the sample size in a finite population.

$$= \frac{2\ (1-)\bullet}{2} \qquad \frac{}{+\ 2+\ (1-\ )/\ 2} \qquad \text{Equation 1}$$

where, the sample size (*n*), a critical value corresponding to the confidence level (*Z*), the margin of error (*and*), the expected proportion (*p*), and the population (*N*).

The required sample size was 383 companies for a population of 111,545 ((INVESTE SÃO PAULO, 2024). To achieve this sample size, professionals from the target population were identified on corporate websites and social networks, such as LinkedIn. After identifying these contacts, the questionnaires (Table 1) were sent via email and social networks, with an electronic form used to collect data.

Table 1 - Block items and number of questions

Block	Block item	Number of questions
1	Characterization of the respondent and the company. If you	4
2	have improvement programs, how long do they last?	10
3	The degree of importance for the use and dissemination of statistics. The	5
4	level of presence of statistical thinking (SP).	5
5	The frequency of use of statistical techniques (ST).	4
Total		28

Source: Own elaboration.

The reliability of the data was assessed using Cronbach's Alpha and McDonald's Omega coefficients. Data analysis employed univariate methods, such as descriptive statistics and the chi-square test, to evaluate specific associations, and multivariate methods, such as cluster analysis, to identify patterns of use and dissemination of statistical knowledge among the companies in the studied region.

4 RESULTS AND DISCUSSION

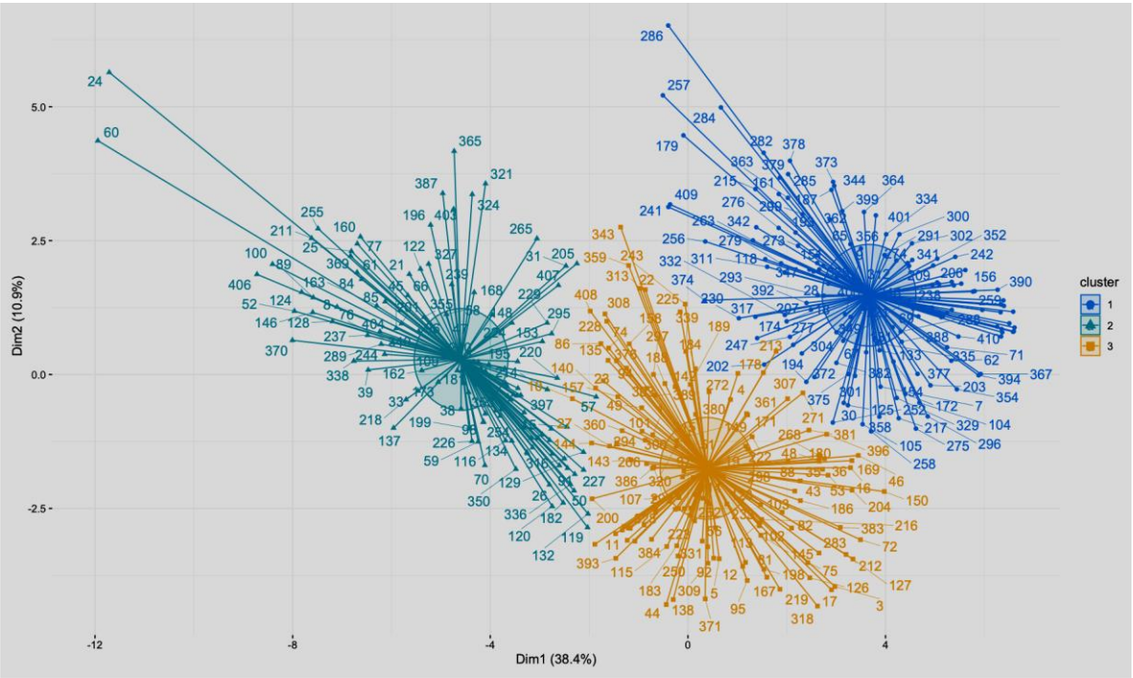
In this section, the results of the empirical investigation are presented, focusing on the gap between theoretical learning and practical application of statistics. The primary objective was to assess the presence and application of statistical thinking principles, as well as statistical techniques, in the routines of the 410 analyzed companies (>383 companies). The study sought to identify the relevance attributed to statistical knowledge within the organizational context and to pinpoint critical factors and opportunities that could enhance the dissemination of statistical thinking and the use of statistical techniques.

The initial analysis of data reliability, essential for ensuring the validity of subsequent analyses, revealed high internal consistency (VIEIRA, 2019): Cronbach's Alpha coefficient showed an overall value of 0.95, while McDonald's Omega reached 0.98, reinforcing the robustness of the scale employed. These results confirm the quality of the data collected and provide a solid foundation for the following stages of analysis and discussion.

4.1 CLUSTER ANALYSIS

Cluster analysis was used to identify distinct groupings among companies in the MRS based on the presence of the principles of statistical techniques and the use of statistical techniques in their activities. The graphical representation of this is shown in Figure 1. The aim is to reveal distinct patterns or segments among the organizations, explore the different statistical approaches they adopted, and investigate the variables associated with these groupings.

Figure 1 - Representation of the Clusters formed - Non-Hierarchical Method



Source: Own elaboration.

According to Metz (2006), assigning concepts or labels to clusters is a fundamental part of the knowledge discovery process. In the first analysis of the clusters, the concepts that can explain the elements contained in the same cluster were identified. The author suggests subjectively evaluating the clusters to check for practical significance and differences based on the patterns represented in each cluster.

Table 2 below shows the composition and labels assigned to each cluster. Cluster 1 covers 34% of the sample and was named "Beginners" because it was the cluster with the most frequent responses at lower levels of agreement or frequency on the Likert scale. The "Advanced" cluster represented 31% of the sample and was characterized by predominant indications at higher scale levels, reflecting higher agreement or frequency. The "Intermediate" cluster covers 35% of the sample and presents results between the other two clusters.

Table 2- Composition and classification of each cluster

Cluster	Sample size per cluster	Concepts assigned	Percentage (%)
1	141	Beginners	34
2	143	Intermediaries	35
3	126	Advanced	31
Total	410		100

Source: Own elaboration.

Analysis of the variables that characterize professionals and companies - education level, position or function, size, and economic area - showed that only the respondents' education level did not influence the formation of clusters. On the other hand, economic sectors,

positions, and functions were significantly associated with the composition of the clusters, indicating that these characteristics were decisive in the organization of the groupings. The different proportions of advanced, intermediate, and beginner clusters in each job or role suggest that specific responsibilities influence the formation of *clusters* and open the discussion on the need for more contextualized statistical education.

These results suggest that teaching statistics in higher education could benefit from a flexible and adaptive approach, incorporating case studies and practical projects that connect students to real situations. The PPDAC investigative cycle (Problem, Planning, Data, Analysis, and Conclusion), as discussed by Wild and Pfannkuch (1999) and adopted by some educators, such as Batanero and Díaz (2011), provides a practical methodology for teaching statistics, encouraging statistical literacy through an interactive and project-based approach.

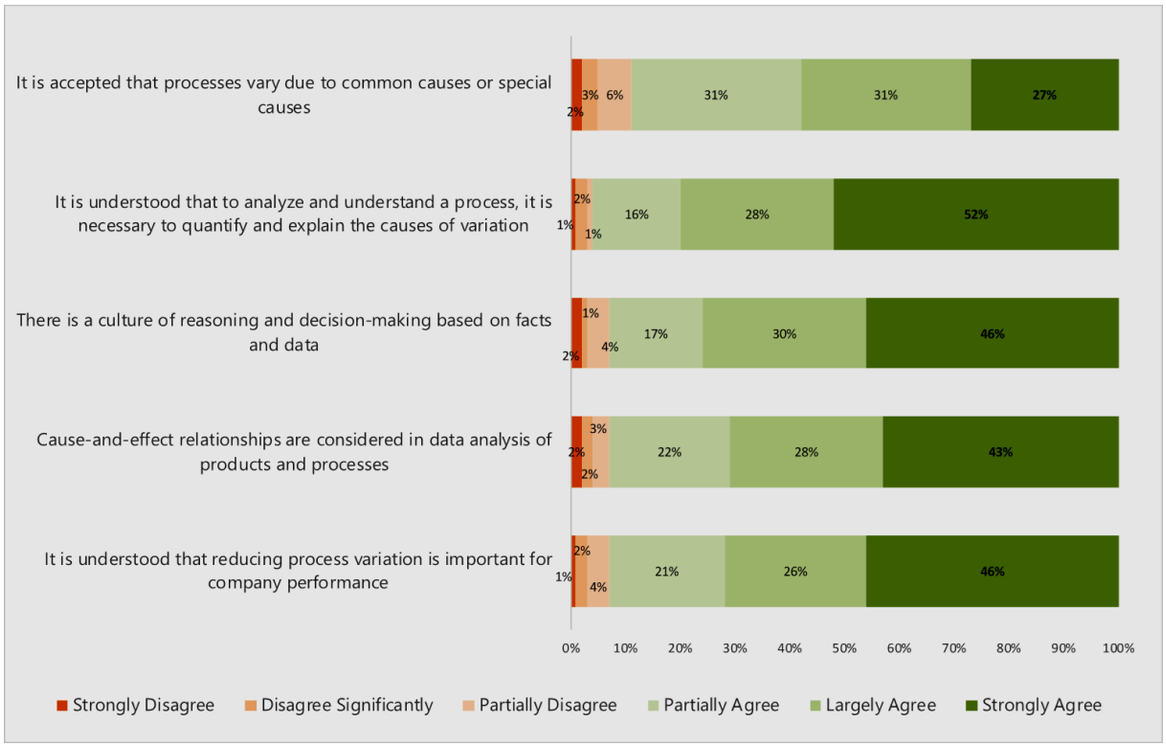
4.2 PRESENCE OF THE PRINCIPLES OF STATISTICAL THINKING

The results indicate that many respondents recognize the importance of quantifying and explaining variations in process analysis. This recognition demonstrates a growing appreciation of using statistics to understand variability in organizational processes. However, as shown in Graph 2, the percentage of agreement decreases for the statements that process variations are caused by common or unique factors, which raises concerns about understanding and effectively managing these different types of variation.

The analysis of the presence of statistical thinking reveals a weakness in the professionals' knowledge of a principle of statistical thinking: the distinction between common causes and special causes of variation, which is fundamental for correct interpretation and intervention in processes. According to Deming (1997), a proper understanding of the causes of variation is indispensable for quality control and the continuous improvement of organizational processes.

Statistical literacy and statistical thinking are interrelated concepts that form part of understanding and applying statistics. According to Gal (2002), as presented in the theoretical framework, statistical literacy is built on cognitive and affective components, including statistical knowledge, mathematical knowledge, awareness of the context, competence in developing questions, and attitudes and beliefs that shape the individual's worldview.

Graph 2 - Level of statistical thinking



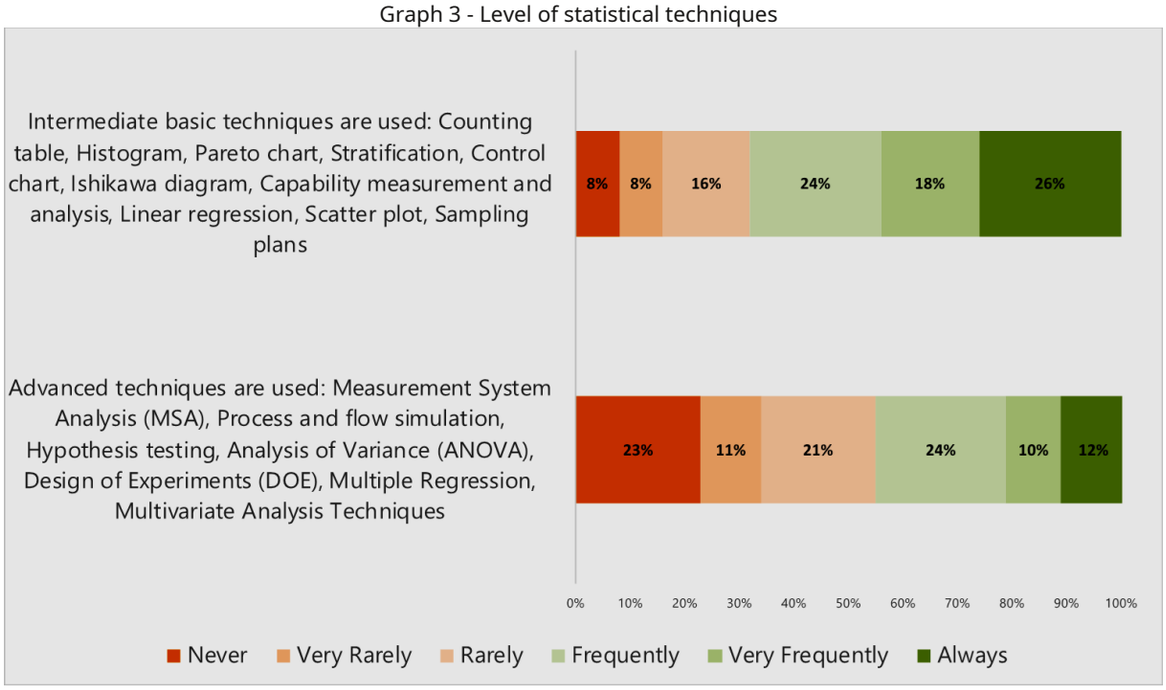
Source: Own elaboration.

These elements are fundamental to the development of statistical thinking, which, according to Snee (1990), encompasses the recognition of variation, the need for data, and the use of statistical methods and tools for decision-making.

4.3 THE USE OF STATISTICAL TECHNIQUES

Considering the literature review, the analysis of the results showed, according to Graph 3, a tendency among companies to prioritize applying essential to intermediate-level statistical techniques. In contrast, the adoption of advanced statistical techniques is less frequent. This pattern suggests that organizations face barriers when tackling more complex production problems, which require more sophisticated analytical methods and a more significant investment in human and technological resources.

Graph 3 - Level of statistical techniques



Source: Own elaboration.

One aspect of the development of statistical literacy is inferential reasoning, as highlighted by Makar and Rubin (2009). These authors distinguish between formal statistical inference, based on traditional procedures such as estimating parameters and testing hypotheses, and informal statistical inference, based on observing data patterns and formulating hypotheses and generalizations without strictly following conventional statistical methods.

Informal inferential reasoning offers an important way of tackling the complexity inherent in advanced statistical concepts. It allows students, or even company professionals, to make inferences and informed decisions based on patterns observed in the data, even before fully mastering advanced ST. According to Cazorla and Giordano (2021), this type of reasoning is particularly relevant in statistical teaching, as it promotes a deeper understanding of phenomena by considering the interactions between variables in an intuitive and accessible way.

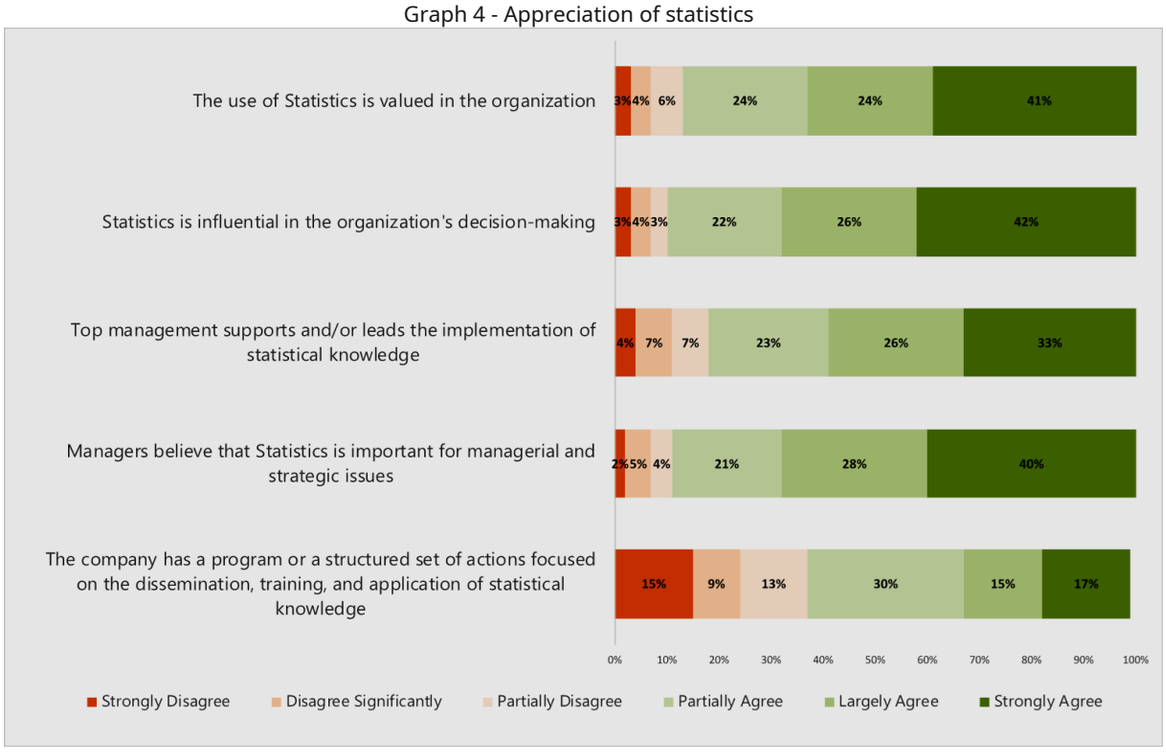
This approach can foster greater applicability of ET and help companies deal with the variability and complex challenges of their production processes.

4.4 ENHANCED THE USE AND DISSEMINATION OF STATISTICS IN COMPANIES Analysis of the

results, as shown in Graph 4, revealed a contradictory perception among professionals about the value of statistical knowledge in the business environment. Although most respondents recognize that managers see statistics as central to strategies and

organizational management, the data suggests a gap in adequate support from top management in promoting and integrating statistical knowledge into the day-to-day running of companies. There needed to be more agreement regarding support to create an environment that favors continuous learning, dissemination, and practical application of statistical knowledge.

Graph 4 - Appreciation of statistics



Source: Own elaboration.

This contradiction highlights a significant challenge: Statistics is recognized as a strategic asset, but implementing a culture that favors its practical use is limited. This issue points to the importance of developing educational and training strategies that incorporate the principles of statistical thinking and statistical techniques, not only at operational and executive levels. For statistics to be integrated into organizational practices, leadership must function as a facilitator of change, creating the conditions for statistical knowledge to be disseminated and applied at all levels of the organization.

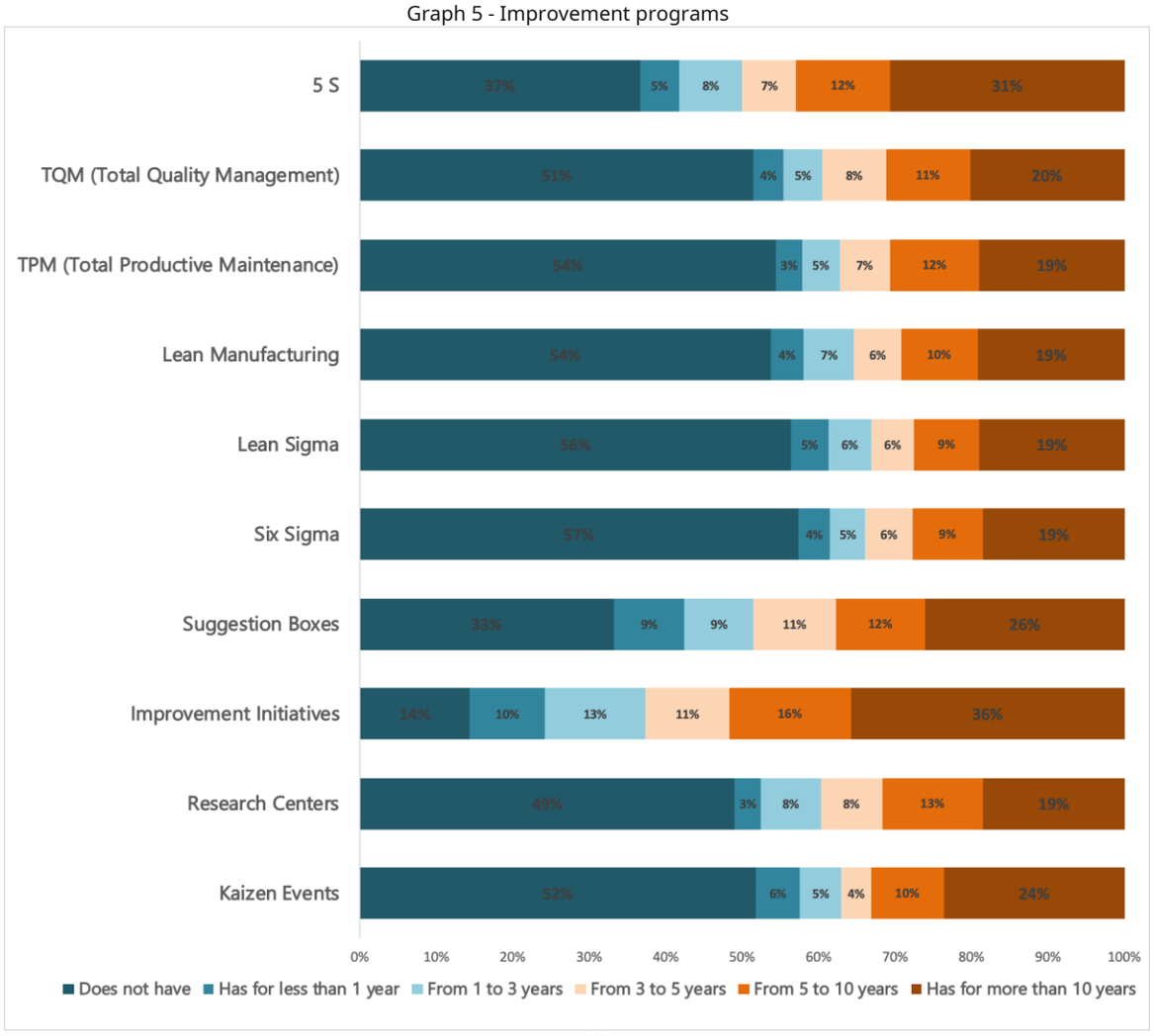
4.5 THE USE AND FREQUENCY OF IMPROVEMENT PROGRAMS

The research investigated the adoption of improvement programs in companies, focusing on those based on the principles of statistical thinking and the use of advanced statistical techniques, such as Six Sigma, Lean Six Sigma, Lean Manufacturing, Total Productive Maintenance (TPM), and Total Quality Management (TQM). The aim was to

identify which programs are implemented in organizations and to evaluate the period or duration of their use.

According to Graph 5, the data analysis indicated a prevalence in traditional improvement programs, such as suggestion programs and initiatives independent of advanced statistical knowledge. In contrast, it was found that more structured programs based on the principles of statistical thinking and statistical techniques, such as Six Sigma and Lean Six Sigma, were adopted less by the participating companies. Most organizations placed these programs in the "not used" category.

Graph 5 - Improvement programs



Source: Own elaboration.

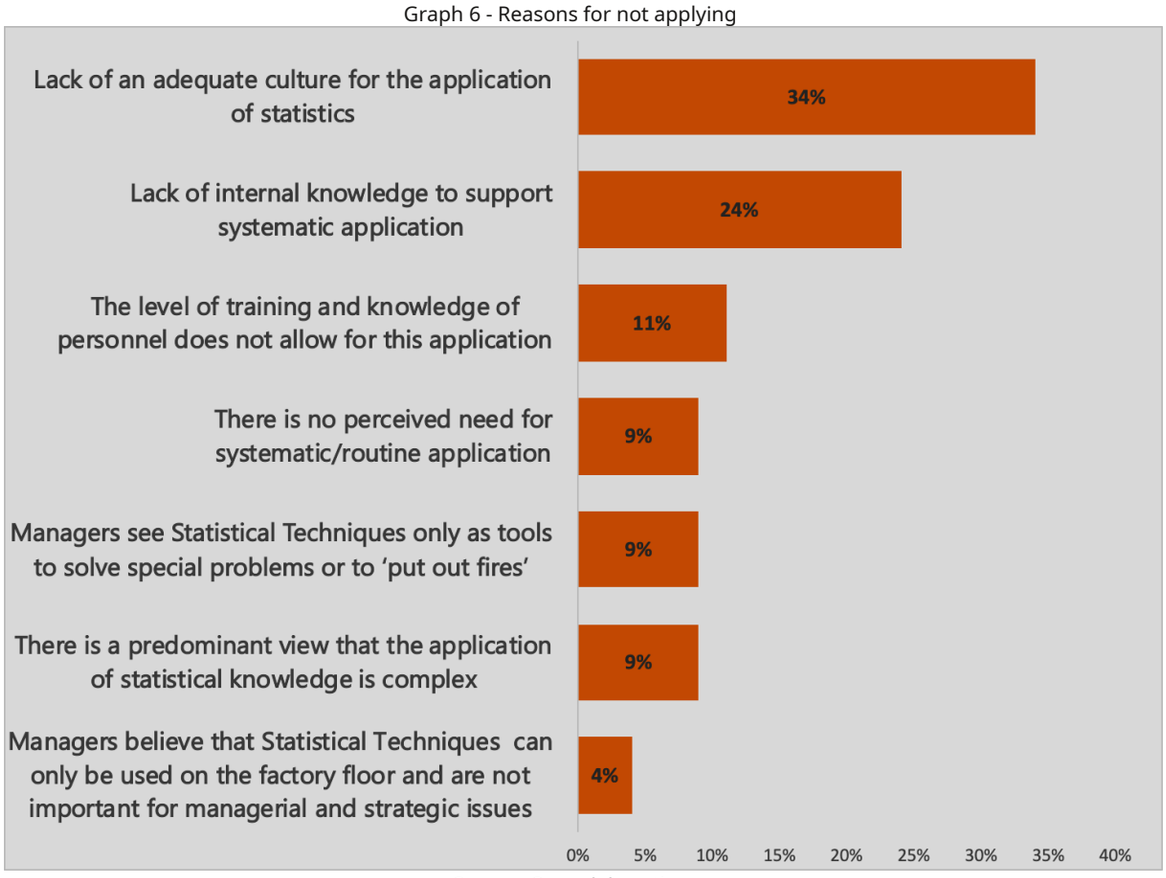
This lack of adoption may also reflect a barrier related to the training of professionals and the need for more support from leadership to invest in more sophisticated programs. Our study highlights the importance of aligning statistical literacy with companies' needs to

overcome this absence of support and creating educational and training programs that prepare professionals with the necessary tools to implement programs such as Six Sigma and Lean Manufacturing more effectively.

4.6 CRITICAL POINTS FOR IMPLEMENTING STATISTICAL TECHNIQUES

The results presented in Graph 6 show that the main challenges faced by organizations in implementing statistical thinking and techniques are linked to educational and training barriers. 34% of respondents pointed out the need for an organizational culture that values statistics, indicating that statistics are still seen as a reactive tool used only to solve specific problems rather than being integrated as a continuous practice for improving processes and strategic decisions.

Graph 6 - Reasons for not applying



Source: Own elaboration.

In addition, 24% of respondents highlighted the lack of specialized knowledge, highlighting the need for more significant investment in training and development. Other obstacles include the low level of employee training (11%), the restrictive view of statistics

techniques for emergencies (9%), and the perception of their complexity (9%). Only 4% of the responses mentioned a limited view by managers of the strategic importance of statistics.

The prevalence of obstacles related to the lack of organizational culture and the lack of specialized knowledge illustrates the gap between theory and practice in the teaching of statistics. The lack of preparation of professionals to apply the techniques in the business context directly reflects an education that still needs to be fully adapted to the practical demands of the market, limiting the potential of organizations to take advantage of statistics as a tool for continuous transformation.

5 CONSIDERATIONS

This research confirmed the difficulty professionals have in applying statistics and the principles of statistical thinking in the business context and conclude that this is a reflection of an education that is not yet fully adapted to the practical demands of the market, limits the potential of organizations to take advantage of statistics as a tool for continuous transformation, and shows a disconnect between the tools available and what is practiced in organizations. Operational and strategic activities still need a complete incorporation of the statistical approach, which reflects organizational barriers such as the lack of a culture that values statistics and insufficient specialist knowledge. In addition, the results highlight the importance of leadership engagement in promoting a data-driven culture, where the competent use of statistics drives innovation and performance.

The analysis also highlighted the importance of statistics education in training professionals to interpret and use data efficiently, connecting theory and practice. The article proposes to discuss ways to overcome this gap in teaching statistics in higher education using the statistical literacy approach. In addition to increasing efficiency and reducing costs, statistical education should prepare professionals to implement continuous improvement programs, boosting competitiveness and sustainable development in companies.

The promotion of statistical literacy, also inspired by Paulo Freire, goes beyond simply understanding graphs and numbers. It consolidates it as a fundamental skill for modern life and proposes teaching that transforms MRS students into active participants in the learning process, rejecting passive education without context. By recognizing the importance of practical skills, critical thinking, and an ethical attitude towards data, teaching statistical literacy in higher education should better prepare students to face the challenges of the professional environment.

Finally, practical statistical education aimed at solving real problems and adapting to new digital realities is essential to overcome the barriers to applying statistical techniques in organizations. This education must be the basis for an equitable society and sustainable development through strategic decisions based on data and university-company collaboration.

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