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Management factors analysis associated with the financial performance of Micro and Small Businesses in Barretos (SP)

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Abstract

Objective: To identify the Management Excellence Factors (MEFs) and the degree of management maturity, productivity and competitiveness associated with the financial performance of Micro and Small Enterprises (MSEs) in the city of Barretos (SP), Brazil.
Methodology: The research is quantitative and explores two databases of the MPEs: i) Documentary: Registration of the Brazilian Micro and Small Business Support Service (SEBRAE) of Barretos; ii) Survey: Application of the MEG questionnaire from the National Quality Foundation (FNQ). A descriptive data analysis from 200 MSEs belonging to different segments (Services, Industry, Commerce and Civil Construction) and statistical tests (Chi-square tests of Independence and Binary Logistic Regression) are carried out using the software Minitab®.
Relevance: The mortality of MSEs before four years of age is close to 77.9% in Brazil. However, MSEs represent around 93.6% of the private companies in Brazil. The literature, to understand the MEFs of MSEs, has used the "World Class" Management Excellence Model (MEG). However, few studies use MEGs to analyze the impact of managerial factors on the performance of MSEs. This research addresses this gap by delving deeper into understanding the application of MEGs and their relationships with the financial performance of SMEs.
Main results: The statistical analysis shows that the factors "People", "Processes" and "Leadership and Innovation" have a positive impact on the MSEs' financial performance (p-value < 0.05). Furthermore, the main sociodemographic factors are "Education" and "Experience with Entrepreneurship" (p-value < 0.05). The conclusions highlight the use of MEG as a subsidy for policy development for MSEs.
Main contributions: Most studies on MEGs focus on large organizations rather than SMEs. In this sense, this research provides significant insights into the key factors that enhance management maturity and financial performance of SMEs. Therefore, this research contributes to the understanding of standards of management excellence and to the development of more effective strategies to improve the financial performance and competitiveness of MSEs.

Keywords: management factors, micro and small business, management maturity, excellence in management model

Resumo

Análise dos fatores gerenciais associados ao desempenho financeiro de Micro e Pequenas Empresas de Barretos (SP)

Objetivo: Identificar os Fatores Gerenciais de Excelência (FGEs) e o grau de maturidade, produtividade e competitividade da gestão associados ao desempenho financeiro das Micro e Pequenas Empresas (MPEs) da cidade de Barretos (SP).
Metodologia: A pesquisa é quantitativa e explora duas bases de dados das MPEs: i) Documental: Cadastro do Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (SEBRAE) de Barretos; ii) *Survey*: Aplicação do questionário MEG da Fundação Nacional da Qualidade (FNQ). Uma análise descritiva dos dados de 200 MPEs pertencentes a diferentes segmentos (Serviços, Indústria, Comércio e Construção Civil) e testes estatísticos (Qui-quadrado de Independência e Regressão Logística Binária) são realizados utilizando o software Minitab®.
Relevância: A mortalidade das MPEs antes dos quatro anos aproxima-se de 77,9% no Brasil. Entretanto, as MPEs representam cerca de 93,6% das empresas privadas do Brasil. A literatura, para compreender os FGEs das MPEs, tem empregado o Modelo de Excelência da Gestão (MEG) de "Classe Mundial". Porém, poucas pesquisas utilizam MEGs para analisar o impacto dos FGEs no desempenho das MPEs. Esta pesquisa satisfaz essa lacuna ao realizar um maior aprofundamento à compreensão da aplicação dos MEGs e suas relações com o desempenho financeiro das MPEs.
Principais resultados: As análises mostram que os fatores "Pessoas", "Processos" e "Liderança e Inovação" impactam positivamente no desempenho financeiro das MPEs (valor-p < 0,05). Além disso, os principais fatores sociodemográficos são a "Escolaridade" e as "Experiências com Empreendedorismo" (valor-p < 0,05). As conclusões evidenciam o uso do MEG como subsídio para o desenvolvimento de políticas para as MPEs.
Principais contribuições: A maior parte da literatura sobre MEGs foca nas grandes organizações e não nas MPEs. Neste sentido, esta pesquisa apresenta respostas sobre quais os principais fatores que potencializam a maturidade da gestão e o desempenho financeiro das MPEs. Portanto, esta pesquisa contribui para a compreensão dos padrões de excelência de gestão e para o desenvolvimento de estratégias mais eficazes à melhoria do desempenho financeiro e competitividade das MPEs.

Palavras-chave: fatores gerenciais, micro e pequenas empresas, maturidade da gestão, modelo de excelência da gestão

Resumen

Análisis de los factores gerenciales asociados al desempeño financiero de Micro y Pequeñas Empresas de Barretos (SP)

Objetivo: Identificar los Factores Gerenciales de Excelencia (FGEs) y el grado de madurez, productividad y competitividad de la gestión asociados al desempeño financiero de las Micro y Pequeñas Empresas (MPEs) de la ciudad de Barretos (SP).
Metodología: La investigación es cuantitativa y explora dos bases de datos de las MPEs: i) Documental: Catastro del Servicio Brasileño de Apoyo a las Micro y Pequeñas Empresas

(SEBRAE) de Barretos; ii) Survey: Aplicación del cuestionario MEG de la Fundación Nacional de la Calidad (FNQ). Se realiza un análisis descriptivo de los datos de 200 MPEs pertenecientes a diferentes segmentos (Servicios, Industria, Comercio y Construcción Civil) y pruebas estadísticas (Chi-cuadrado de Independencia y Regresión Logística Binaria) utilizando el software Minitab®.
Relevancia: La mortalidad de las MPEs antes de los cuatro años se aproxima al 77,9% en Brasil. Sin embargo, las MPEs representan cerca del 93,6% de las empresas privadas de Brasil. La literatura, para comprender los FGEs de las MPEs, ha empleado el Modelo de Excelencia de la Gestión (MEG) de "Clase Mundial". No obstante, pocas investigaciones utilizan MEGs para analizar el impacto de los FGEs en el desempeño de las MPEs. Esta investigación satisface esa laguna al realizar una mayor profundización en la comprensión de la aplicación de los MEGs y sus relaciones con el desempeño financiero de las MPEs.
Principales resultados: Los análisis muestran que los factores "Personas", "Procesos" y "Liderazgo e Innovación" impactan positivamente en el desempeño financiero de las MPEs (valor-p < 0,05). Además, los principales factores sociodemográficos son la "Escolaridad" y las "Experiencias con Emprendimiento" (valor-p < 0,05). Las conclusiones evidencian el uso del MEG como subsidio para el desarrollo de políticas para las MPEs.
Principales contribuciones: La mayor parte de la literatura sobre MEGs se centra en las grandes organizaciones y no en las MPEs. En este sentido, esta investigación presenta respuestas sobre cuáles son los principales factores que potencializan la madurez de la gestión y el desempeño financiero de las MPEs. Por lo tanto, esta investigación contribuye a la comprensión de los patrones de excelencia de gestión y al desarrollo de estrategias más eficaces para la mejora del desempeño financiero y la competitividad de las MPEs.

Palabras clave: factores gerenciales, micro y pequeñas empresas, madurez de la Gestión, modelo de excelencia de la gestión

Introduction

Competition is intense in the economic and business environments of Micro and Small Enterprises (MSEs). This requires strengthening competitiveness through constant innovations and technologies that improve the processes and management methods of MSEs (Casarotto Filho, 2001; Kamimura et al., 2023; Zanin et al., 2023). The issue is that, in Brazil, the mortality rate of MSEs, before completing four years of age, is around 77.9%, while in Medium and Large Companies this rate is 3% (Instituto Vox Populi, 2017; BigDataCorp, 2024). The average survival of MSEs after ten years of activity is approximately 1% (BigDataCorp, 2024). Interviews conducted by the Vox Populi Institute (2017) showed that entrepreneurs consider managerial skills (68%) and failures (38%) as the main factors of success and failure in SMEs. Entrepreneurs who admitted to having sought specialized management help totaled 48% (Vox Populi Institute, 2017).

There are also several studies that are dedicated to carrying out a more in-depth analysis of the factors (capital, socioeconomic environment, access to management tools, etc.) that impact the performance of SMEs. Examples are the studies by Escrivão Filho (1995), Ribeiro & Panhoca (2005), Hilário & Colombo (2017), Galli-Debicella (2021), Thomas & Douglas (2021), Curado et al. (2022), Franczak & Weinzimmer (2022), Lelimawarti et al. (2024), and Neves et al. (2024).

Performance improvement usually considers the so-called Management Excellence Factors (MEFs). These MEFs are related to the approaches of organizations to adapt to constantly changing environments and can imply the success or failure of SMEs (Thompson & Yujun, 2003; Laí et al., 2016; Oliveira & Gomes, 2024). The identification of MEFs associated with organizational performance is usually carried out through the so-called Management Excellence Models (MEGs). The literature, aiming to measure and improve business performance, has presented important research on MEGs (see Kaplan & Norton (2004), York & Miree (2004), Gumbus & Lussier (2006), Ham et al. (2015), Santos et al. (2018) and Barrantes-Briceño et al. (2024)). The application of MEGs focuses on helping companies achieve "World Class" management standards or criteria of excellence (Teixeira et al., 2015; FNQ, 2024). In Brazil, the degree of maturity, productivity and competitiveness is measured by the MEG of the National Quality Foundation (FNQ).

In 2015, the National Management Maturity Indicator (INMG) measured by MEG reached its highest mark of 64.7 points (FNQ, 2015). This indicates that 64.7% of management practices were applied by companies that used MEG. Serasa Experian, from December 2000 to December 2013, compared the financial performance of 261 companies that applied MEG. These companies presented revenues above 11.9% and profitability of 4.3%, while the other organizations had 2.8% (Serasa Experian, 2014; FNQ, 2015). In 2022, Serasa Experian started the Impulsiona Project together with the Brazilian Micro and Small Business Support Service (SEBRAE) aiming to improve the competitiveness of 114 SMEs and whose financial results were evaluated by MEG. The competitiveness of these SMEs increased by 75% (from 3.78 to 6.61) with increases in net margin (18%) and average revenue (7%), in addition to reducing debt by 58% (Serasa Experian, 2024).

Management maturity is an important factor in improving the performance of SMEs, according to Matsumoto et al. (2015), Brito & Barbosa (2016), Fonseca & Silva (2017), Machado et al. (2020) and Correia et al. (2021). However, the literature shows that most of the most advanced research related to MEGs focuses on large companies, while occasional case studies

address SMEs (Machado et al., 2020). This has raised an important question regarding the importance of SMEs: What are the main factors that enhance management maturity and the financial performance of SMEs? There is, therefore, a clear demand for more in-depth research on the understanding, application and relationships of MEGs with management systems that are more suited to the reality of the financial performance required by SMEs. Machado et al. (2020) emphasize that excellence models developed for large companies are not suitable for SMEs and do not offer discretionary capacity for SMEs. Advances in this type of research are essential and contribute to the development of SMEs in Brazil. In this sense, this research aims to identify the FGEs, sociodemographic factors, and the degree of management maturity associated with the financial performance of SMEs in the city of Barretos, state of São Paulo. The research analyzed 200 SMEs from four different segments (Industry, Commerce, Services, and Civil Construction) located in Barretos. Therefore, this research is limited to these SMEs and performs a descriptive analysis of the data and statistical tests (Chi-square of Independence and Binary Logistic Regression) performed using Minitab® software.

The results of this study are very relevant since SMEs need to improve since they are fundamental to the global and Brazilian economy (BigDataCorp, 2024; Lelimawarti et al., 2024; SEBRAE, 2024b). In the Barretos municipality region alone, there are 19.9 thousand active companies and around 90% are SMEs (JUCESP, 2023). However, these companies are far from meeting the parameters of the current MEG (Machado et al., 2020). The issue is that most SMEs have a high mortality rate and have an average productivity of only 30% compared to that of large companies in Brazil (BigDataCorp, 2024; SEBRAE, 2024a). In view of this scenario, the focus of this research is to provide important contributions to the development of more effective strategies to improve the management and financial performance of SMEs in Barretos. It is important to emphasize that the scope of this research is not to provide the state of the art or identify the limitations, particularities and critical success factors of SMEs in Brazil. This research does not address public policies or perform comparative analyses between different regions and/or economic sectors of the most diverse types of SMEs in Brazil. From now on, this paper is structured as follows: section 2 presents the FGEs of SMEs; section 3 introduces the basic concepts on MEGs; section 4 presents the research method; section 5 details the experiments and presentation of the results obtained for SMEs. Finally, the paper presents a concluding section

where some considerations and suggestions are presented for future research aimed at the application of MEGs for SMEs.

Management Factors and the Financial Performance Of SMEs

The General Law of Microenterprises and Small Businesses was established in 2006 (Complementary Law No. 123, of December 14, 2006). This Law uses the gross revenue obtained each calendar year to differentiate Microenterprises from Small Businesses. Microenterprises are those whose gross revenue is equal to or less than R$360 thousand, while in Small Businesses the values are greater than R$360 thousand and equal to or less than R$4.8 million (SEBRAE, 2022). The Global Entrepreneurship Monitor (GEM) survey showed that the desire of Brazilians to undertake reached the highest rate (60%) in 2022, with an increase of 14% compared to 2021 (GEM, 2022). This research corroborates the fact that SMEs generated 85.5% (206.7 thousand) of job openings in Brazil until February 2023 (CAGED, 2023). SMEs opened in 2023 reached 3.77 million (an increase of 6.6%) and represented more than 80% of formal jobs created in the same year in Brazil (MEMP, 2024; SEBRAE, 2024c; SEBRAE, 2024d). In 2023, Brazil already had 20.7 million active companies and approximately 99% were classified as SMEs (MDIC, 2023; SEBRAE, 2023). These SMEs became responsible for 55% of formal jobs in Brazil (SEBRAE, 2023).

It is also observed that the share of SMEs in Brazil's Gross Domestic Product (GDP) has shown a reasonable increase over the years, growing from 21% in 1985 to 30% (R$3.3 trillion) in 2023 (SEBRAE, 2015; BigDataCorp, 2024; SEBRAE, 2024b). More recent analyses show that SMEs account for approximately 93.6% of the more than 21.1 million companies in operation in the first four months of 2024 alone (MEMP, 2024). All these indicators are very important because they demonstrate the relevance of SMEs in moving global markets in the short term and in impacting Brazil's economic scenario. However, the characteristics and specificities in the structure and management processes are very different when comparing large organizations with SMEs. Most of them are inserted in a context of high interest rates, reduced teams, product variety, low production volumes and owner-centered management (De Amorim, 2019; Zanin et al., 2023; CNI, 2024). Ineffective socioeconomic policies linked to resource and/or capital restrictions for training and investments impact technical capacity, lack of specialists, low differentiation and

access to technological innovations in a way that limits the development of SMEs (see Galli-Debicella (2021), Padilla-Ospina et al. (2021), Thomas & Douglas (2021), Curado et al. (2022), Franczak & Weinzimmer (2022), CNI (2024), Lelimawarti et al. (2024) and Neves et al. (2024).

It is important to point out that the most sophisticated existing management methods or tools are generally expensive and/or complex and are still beyond the reach of most SMEs (Ribeiro & Panhoca, 2005; Kamimura et al., 2023). The absence of management systems and the use of intuitive strategies without planning and/or management indicators lead to excessive operationality and performance limitations that can lead to the failure of SMEs (Ribeiro & Panhoca, 2005; Hilário & Colombo, 2017; Albuquerque et al., 2023). In general terms, the average productivity of Brazilian SMEs when compared to large companies is around 30% (SEBRAE, 2024a). It is also clear that the demands for greater competitiveness and elimination of waste are more evident in large companies than in SMEs (Zanin et al., 2023). However, many SMEs operate in markets that rival large companies and whose competitiveness requires tools that enable managers to make decisions quickly and consistently (Pinto et al., 2018; Galli-Debicella, 2021; Curado et al., 2022). These issues have drawn the attention of many public and private agencies to the importance of considering the FGEs that impact the success of SMEs. Such factors play an important role in adapting to a constantly changing environment and in correcting the course of SMEs (Laí et al., 2016; Thompson & Yuju, 2003). To improve the performance of SMEs, academic literature has proposed the use of MEGs. However, there is still little research whose scope is to analyze the impact of FGEs on the organizational performance of SMEs through the adoption of MEGs. Table 1 provides a summary of research that raises FGEs and their relationship with the organizational performance of SMEs.

The research conducted by Paulzen et al. (2002) showed that the FGEs most favorable to the performance of SMEs were “Processes” (focus on processes and continuous quality improvement) and “People” (employee involvement). York & Miree (2004) conducted a survey in the city of Rochester in the United States (USA), with a sample of 435 SMEs that won the Baldrige Performance Excellence Program (BPEP) award from the National Institute of Standards and Technology (NIST) in 2001. The study identified a positive relationship between financial performance superior to that of other companies and the FGEs “Processes” and “Customers”. After a considerable period, Matsumoto et al. (2015) analyzed 44 SMEs in the commerce, industry and

services sectors of the Federal District and Northeast of Brazil. The research identified that the FGE with a positive impact on organizational performance was "People".

Table 1

Management factors of excellence and organizational performance

Research Authors (Bibliographic References)	Management Factors (Greatest Influence on Performance)
Paulzen et al. (2002)	People and Processes
York & Miree (2004)	Customers and Processes
Brito & Barbosa (2016)	Processes, Leadership, and Innovation
Cândido & da Silva (2016)	People, Innovation, and Society
Garza-Reyes (2016)	Processes
Motta et al. (2016)	Processes, Leadership, and Innovation
Tickle et al. (2016)	Customers, Information, Leadership, and Innovation
Comfield & Mendes (2017)	Processes, Leadership, and Innovation
Hilário & Colombo (2017)	Customer, People, and Society
Fonseca & Silva (2017)	People, Processes, and Society
Machado et al. (2020)	People, Processes and Strategy
D'anjour et al. (2023)	Leadership and Innovation

Source: The Authors

Most of the research on SMEs was conducted in the year 2016 as the study of Brito & Barbosa (2016) applying the MEG to 40 food SMEs in the metropolitan region of the city of Recife (PE), Brazil. The research showed that the FGEs that most contributed positively to the performance of SMEs were related to "Processes" and "Leadership and Innovation". Cândido & da Silva (2016) determined the dimensions of the MEG that contribute to the growth of SMEs. The research analyzed 1006 SMEs from representative sectors (Services, Commerce, Industry and Agribusiness) in Santa Catarina (SC), Brazil. The Mann-Whitney scale (*U* test) compared the means of the SMEs, and the MEG dimensions were obtained by Binary Logistic Regression (BLR) models. Microenterprises did not present effectiveness results for the MEG and Small Enterprises obtained significant FGEs for "People", "Innovation" and "Society". Garza-Reyes (2016) highlighted the importance of assessing the level of management maturity through the MEG and

identifying practices to improve organizational performance with an emphasis on the "Processes" FGEs. Motta et al. (2016) applied the MEG and identified "Processes" and "Leadership and Innovation" as the most critical FGEs for the performance of 449 SMEs in Rio Grande do Norte (RN), Brazil. Tickle et. al. (2016) analyzed five Asian countries and 74 SMEs comparing the presence of the MEG FGEs, the BPEP and the European Foundation for Quality Management (EFQM) Excellence Model. It was demonstrated that the group of companies with high organizational performance stood out due to the "Customers", "Information" and "Leadership and Innovation" FGEs.

Comfield & Mendes (2017) showed that the FGEs of 11 SMEs that favored organizational performance are "Processes" and "Leadership and Innovation". Fonseca & Silva (2017) evaluated the maturity level of 25 companies in the textile and clothing sector in the Arid region of Pernambuco (PE) in Brazil, specifically in Santa Cruz do Capibaribe. The FNQ competitiveness matrix showed that, despite the FGEs with higher averages for "Society", "Processes" and "People", all SMEs were classified as immature by the MEG. Hilário & Colombo (2017) compared 20 companies, equally divided between SMEs and Individual Microentrepreneurs (MEIs), in the municipality of Criciúma (SC) in Brazil. The analyses found that MEIs do not validate themselves from the MEG as MSEs do. The highest FGE averages for SMEs were "Customer", "People" and "Society". More recently, Machado et al. (2020) evaluated 76 SMEs from the State of São Paulo, Brazil, and whose data collection used the FNQ e-Meg software. It is evident that none of the SMEs met any of the eight criteria of the current MEG. This research also proposed an excellence model with only the dimensions "Strategy" and "People and Processes" and specific to SMEs. D'anjour et al., (2023) proposed a multidimensional model to assess innovativeness in SMEs in the Metropolitan Region of Natal (RN), Brazil. The research statistically analyzed 542 SMEs through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). These techniques were applied based on Structural Equation Modeling with Partial Least Squares (PLS-SEM). The development and validation of the model for measuring 30 variables related to 5 constructs for innovativeness was based on the MEG dimensions. The research found that the model focused on the "Leadership" and "Innovation" FGEs can be a guide for the strategic process of innovativeness and competitive advantage in SMEs. An important theoretical framework on the thematic structure and the next research paths on excellence models can be found in Correia et al. (2021) and Oliveira & Gomes (2024).

Management Excellence Models (MEGs)

Main Management Excellence Models (MEGs)

Most MEGs are based on studies in companies considered "World Class" or "Islands of Excellence". These MEGs aim to assist in business management and are based on factors related to finance, quality, strategy, marketing, operations and human resources (De Carvalho et al., 2012; Santos et al., 2018; FNQ, 2024). Certification entities use MEGs to identify what is common and what differentiates one company from other companies in the world (Santos et al., 2018; Rawabdeh et al., 2022). Basic foundations for the formation of a management culture focused on results and competitiveness are identified, broken down into requirements and grouped by FGEs. Certification entities award performance excellence through MGEs. The main entities are the Union of Japanese Scientists and Engineers (JUSE), established in Japan in 1951, and the Malcolm Baldrige of the National Institute of Standards and Technology (NIST), created by the US Department of Commerce agency in 1980 (Dahlgaard-Park et al., 2018). There is also the EFQM, founded in 1988 by 14 companies from Europe and with the support of the European Commission (EFQM, 2007; EFQM, 2024), and the MEG of Brazil, established by the FNQ in 1992 (FNQ, 2024).

Among the models, the JUSE Deming Prize stands out, which is a tribute to Dr. William Edwards Deming for his contribution to the development of the quality of Japanese products in the post-World War II period (Oliveira & Gomes, 2024). In the 1980s, the growth of Japanese industries attracted the attention of the US government. The US response was to encourage the search for a set of concepts that would guide its organizations to become competitive in relation to the threat from Japan (Oliveira & Gomes, 2024). In the mid-1980s, the Malcolm Baldrige National Quality Award (MBNQA) administered by NIST emerged (Rawabdeh et al., 2022). Soon, the EFQM model was widely adopted by various sectors as a basis for evaluating most quality awards in different areas of excellence around the world (Rawabdeh et al., 2022; Oliveira & Gomes, 2024). This model consists of a non-prescriptive business excellence framework that focuses on helping organizations become more competitive (Santos et al., 2018; Oliveira & Gomes, 2024; EFQM, 2024). It is a tool that establishes appropriate management systems for success, measures where one is on the path to excellence, helps understand gaps, and promotes solutions (EFQM, 2007; EFQM, 2024).

The Brazilian Model of Management Excellence

In 1991, it was created in Brazil as a non-governmental and non-profit organization called FNQ (FNQ, 2024). In 1992, FNQ launched the MEG used in the National Quality Award (PNQ), based on the Deming, Baldrige and EFQM models (Santos et al., 2018; FNQ, 2024). As it is considered a flexible and simple-language method (it assesses, diagnoses and guides), any type of company can use the MEG. The understanding of management excellence that structures the MEG is represented by eight FGEs described in Table 2. In addition, a comparison between the management excellence models researched and their respective FGEs is also presented in Table 3. Next, a summary of the descriptive analyses of the IV in relation to the FGEs of the MEG is presented in Table 4.

Table 2

Management factors of excellence of the MEG

Management Factors (Criteria of Excellence)	Definition of Management (Factors Criteria of Excellence)
Leadership and Innovation	Analyzes how managers exercise leadership and how innovations are promoted
Strategies	Analyzes the process of defining strategies and plans (indicators, goals and action plans)
Customers	Analyzes practices for retaining current customers and attracting new customers.
Society	Practice in relation to meeting legal requirements, environmental and social aspects
Information	Analyzes how techniques/knowledge are shared between managers and employees
People	Selection and training, risks and dangers associated with work, well-being and satisfaction
Processes	Analyzes the monitoring of results related to customers, processes and finances
Results	Analisa o acompanhamento dos resultados relativos aos clientes, processos e financeiros

Source: FNQ (2014)

Table 3

Comparison of Management Excellence Models

Management Factors (Excellence Criteria)	Deming Japan	Baldrige USA	EFQM Europe	MEG Brazil
Leadership and Innovation	Yes	Yes	Yes	Yes
Strategies	Yes	Yes	Yes	Yes
Customers	Yes	Yes	Yes	Yes
Society	-	-	Yes	Yes
Information	Yes	Yes	-	Yes
People	Yes	Yes	Yes	Yes
Processes	Yes	Yes	Yes	Yes
Results	-	Yes	Yes	Yes

Source: FNQ (2014)

Table 4

Summary of descriptive analyses of MEG management factors of excellence

Independent Variable (MEG Management Factors)	Classification in Management Practices	Score in Management Practices
-	Level 1 – Existence	0 to 15%
Strategies, Results	Level 2 – Survival	15 to 35%
Leadership, Customers, Information, People, Maturity	Level 3 – Success	35 to 55%
Society, Processes	Level 4 – Growth	35 to 55%
-	Level 5 – Maturity	Above 75%

Source: The authors

All the factors presented in Table 2 are used by a great number of organizations in periodic self-assessments and constitute the basis of continuous improvement programs for management practices in Brazil. Table 3 demonstrates that the MEG is highly consistent with the others and is similar to those of NIST and EFQM. It is noted that the FNQ was based on the main management excellence models and adopted all the FGEs mentioned to create the MEG. The application of a questionnaire that generates information on macro and microenvironments and provides a systemic view is the MEG's support tool. Table 4 shows that companies are then asked about their management practices and each criterion or management factor is analyzed and scored by the MEG. These FGEs are based on a set of excellence fundamentals whose purpose is to help understand and clarify the actions to be taken after the MEG assessment. Thus, the practices and

FGEs that are consistent with the model, the opportunities for improvement and the company's management maturity stage are provided by the MEG.

The Degree of Management Maturity

The application of MEGs results in an evolution of the company's management maturity that culminates in "World Class" excellence (Ribeiro & Panhoca, 2005; Correia et al., 2021; FNQ, 2024). This evolution process is seen as a life cycle in which the management maturity process is fundamental to MEG. The MEG assessment identifies the level or index of adherence of organizations in each of the eight FGEs (FNQ, 2014; Machado et al., 2020; FNQ, 2024). Therefore, each management factor receives a weight and a score, and the sum of these scores, on a scale of 0 to 100%, results in the degree of MEG management maturity (FNQ, 2014). Table 5 details the FGEs' scores in the MEG.

Table 5

Scores of management excellence factors in the FNQ MEG questionnaire

Management Factors (Management Maturity) (Maturidade da Gestão)	Weight of Factors (Percentage) Máxima)	Number of Questions	Weight of Answers
Leadership and Innovation	15.00%	6	a) 0.00 b) 0.75 c) 1.88 d) 2.50
Strategies	9.00%	4	a) 0.00 b) 0.68 c) 1.69 d) 2.25
Customers	9.00%	5	a) 0.00 b) 0.54 c) 1.35 d) 1.80
Society	6.00%	3	a) 0.00 b) 0.60 c) 1.50 d) 2.00
Information	6.00%	4	a) 0.00 b) 0.45 c) 1.13 d) 1.50
People	9.00%	5	a) 0.00 b) 0.54 c) 1.35 d) 1.80
Processes	16.00%	4	a) 0.00 b) 1.20 c) 3.00 d) 4.00
Results	30.00%	6	a) 0.00 b) 1.50 c) 3.75 d) 5.00
Degree of Maturity	**100.00%**	**37**	**-**

Source: FNQ (2014)

By analyzing the scores, it is possible to obtain the company's management maturity level for the FGEs. These levels are divided into five scoring levels, and management maturity is achieved when the company reaches the maximum score in all FGEs. To obtain the maturity level, it is important to consider the level or index of adherence of organizations in each of the eight

FGEs of the MEG (Matsumoto et al., 2015; Correia et al., 2021). The following are the five MEG maturity levels according to the FNQ (2014):

1) Level 1 (Existence) – Management practices of the management factor are not implemented by the company (0 to 15%).
2) Level 2 (Survival) – Management practices of the management factor are rarely implemented by the company (15 to 35%).
3) Level 3 (Success) – Management practices of the managerial factor are implemented by the company, but with a lot of opportunity for improvement (35 to 55%).
4) Level 4 (Growth) – Management practices of the managerial factor are implemented by the company, but still with opportunity for improvement (55 to 75%).
5) Level 5 (Maturity) – Management practices of the managerial factor are implemented by the company (above 75%).

Research Method

This research is applied and quantitative in nature because it employs statistical techniques and analyses of data obtained from SMEs (Bertrand & Fransoo, 2002; Haegeman et al., 2013). The methodological strategy considered the relationships that we wish to elucidate between the variables under study and the universe of SMEs in Barretos, municipality. Therefore, two sources of data collection based on documentary analysis and survey were used as based on Donthu et al. (2021) and Lim et al. (2022). The collection of documentary data was carried out from the SEBRAE cadastral database of the city of Barretos. The survey data collection was carried out through the application of the MEG questionnaire of the FNQ. The research applied the questionnaires and analyzed the data obtained from a total of 200 SMEs from different segments (Services, Industry, Commerce and Civil Construction).

The sample (200 SMEs) was selected according to accessibility criteria and the manager's willingness to participate in the survey and was based on the list of companies formally supported by SEBRAE in the Barretos region. The participating SMEs operate in different economic segments and their managers are part of the SEBRAE Training and Development Program. This program holds periodic meetings with groups of 25 entrepreneurs at a time, known as "Business Meetings". The purpose of this program is to monitor the training and management development

process of SMEs. Therefore, the technical procedure adopted for selecting the SMEs was through an invitation made directly to the managers of the SMEs present at the "Business Meeting" events. Upon the manager's acceptance, the data collection instrument was promptly filled out at the location itself (SEBRAE). This allowed any questions regarding the topic to be clarified on site when filling out the questionnaire and under the supervision of SEBRAE professionals. This procedure was repeated by the researcher at several events until the programmed composition for the different SMEs was totaled. All data corresponds to the 200 questionnaires answered appropriately by 50 SMEs from each segment (Services, Industry, Commerce and Civil Construction). The questionnaire responses were checked by a researcher who participated in the events at SEBRAE and ensured that the SMEs had all the information required by the MEG. That said, situations in which a company does not have certain information, or a certain procedure are promptly captured by the MEG. To verify and capture these occurrences, there is an item, among the multiple alternatives, that represents it in the MEG.

Data analysis was performed using statistical tests and complemented with descriptive analysis of data from SMEs. All data to be analyzed and interpreted respond to the research problem of SMEs. A descriptive analysis considers a set of statistical techniques (summary statistics such as sample mean and sample standard deviation) and graphical methods whose objective is to describe individually and qualitatively the behavior of a variable or relationships between Independent Variables (IV) and a Dependent Variable (DV). Thus, one of the objectives of this research is to use statistical models to evaluate the relationships between the IV (or covariates) associated with SMEs with the response variable of interest (DV). This technique is considered the initial phase of studying collected data (Reis Edna & Reis Ilka, 2002). For the statistical analysis of data related to two categorized factors, non-parametric Chi-square tests of Independence were used (Montgomery & Runger, 2011). Chi-square tests of independence compare the observed values in each class with the expected values under the hypothesis of independence (Plackett, 1983). If the observed values are close to the expected values, then there is independence between the two factors of interest detected by an asymptotic Pearson Chi-square test (see Appendix). For this, a significance level of 0.05 was defined. Thus, the null hypothesis (H_0: there is independence) is rejected and it will be concluded that there is statistical dependence between the two factors if the p-value < 0.05. In addition to Chi-square tests of independence, we also use Binary Logistic Regression (BLR) models. Such models relate to a binary response

classified as success or failure from a non-linear model for the probability of success with one or more covariates (Montgomery & Runger, 2011). This is done to verify which factors (covariates) have significant effects on the probability of success of interest (Montgomery & Runger, 2011). This technique allows the detection of significant factors using hypothesis tests and the prediction of the probabilities of success for each simultaneous combination of the values of the covariates (Hosmer & Lemeshow, 2000).

Minitab® software was used to process the data for all statistical tests. Consequently, the IVs were defined based on the literature review and the MEG's FGEs. This includes the degree of management maturity and its eight FGEs (People, Customers, Processes, Strategy, Society, Information, Results, and Leadership and Innovation). In addition, eight more sociodemographic factors obtained from SEBRAE (2017) in Barretos (SP) were identified: i) Age; ii) Gender; iii) Education; iv) Sector of Activity; v) Revenue Range; vi) Time of Establishment; vii) Number of Employees; viii) Experience with Entrepreneurship. It is in this context that the DV is the financial performance of SMEs. Therefore, the DV or output variable can be quantified and modified (influenced and/or affected) according to the IVs (Prodanov & Freitas, 2013). Therefore, data from the Business Survival Reports in Brazil (SEBRAE, 2016) and the Small Business Overview (SEBRAE, 2018) were used. These reports present the variations in revenue and accumulated profitability, discounting inflation, of each of the 200 companies surveyed in 2017 compared to 2016. To assess whether SMEs had better or worse financial performance, the SEBRAE Database Report (2017) was used, with indicators of SMEs in the city of Barretos by "Sector of Activity". This report showed increases in revenue for the sectors of Commerce (7%), Industry (3%), Services (8%) and Civil Construction (5%). Profitability also increased in Commerce (8%), Industry (5%), Services (10%) and Civil Construction (5%). Therefore, SMEs that present revenue and profitability above these indexes will be considered to have financial performance above their "Sector of Activity".

Experiments and Presentation of Results

This section presents the statistical analyses performed on data related to the SMEs' FGEs. Initially, a descriptive analysis of the FGEs' IV (Leadership and Innovation, Strategy, Customers, Society, Information, People, Processes, Results, and Maturity) was performed. The classification

considered the level or index of adherence of these SMEs to the MEG management practices. To this end, the largest number of SMEs for each level of the FGEs was identified. In the case of the IV, the largest number of SMEs with the most opportunities for improvement is concentrated at level 2-Survival for the "Strategies" and "Results" FGEs. For most SMEs, the two FGE variables that stood out are at level 4-Growth: "Society" and "Processes". It should be noted that the research showed a minority of SMEs at the extreme levels in all FGEs. This occurred both at the worst (1-existence) and at the highest (5-maturity) level of the FGEs. It is possible to determine that the MSEs under study are at an intermediate stage of managerial maturity defined by the MEG. Next, Chi-square tests of Independence were applied to all managerial variables on a categorical scale referring to the 5 levels presented in Table 4. In all cases, there were significant associations or dependencies (p-value < 0.05) of each managerial variable with the financial performance of the MSEs (1 = above average; 0 = below average). Chi-square tests of Independence were also applied to categorical data of the FGEs. This was done by relating each managerial and sociodemographic factor with the financial performance of the MSEs (1 = above average; 0 = below average). The coding of each managerial and sociodemographic factor used in the statistical analysis of the data is presented in Table 6. Next, pie charts for the descriptive interests regarding the characterization and FGEs of the MSEs (Table 6) are illustrated respectively by Figures 1 and 2 while Table 7 presents a summary of the dependency analyses of the IV (Sociodemographic Factors).

Table 6

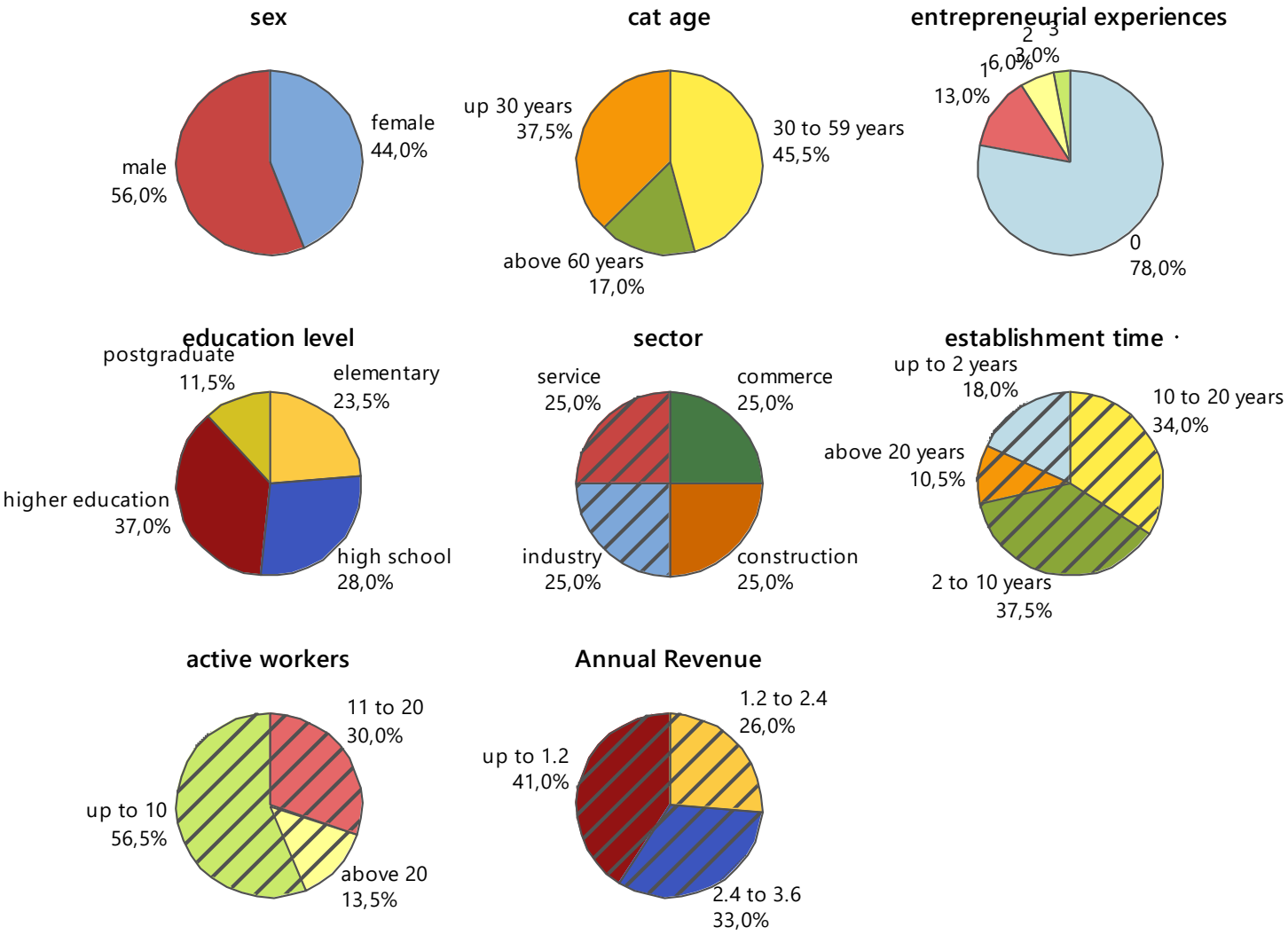
Coding of sociodemographic and managerial factors

Owner Data
▪ **Gender**: 1) Male; 2) Female ▪ **Age Categorized:** 1) up to 30 years; 2) 30 to 59 years; 3) over 60 years ▪ **Experiences with Entrepreneurship:** 1) Quantity ▪ **Education:** 1) Elementary; 2) High school; 3) Higher education; 4) Postgraduate/Master's Degree ▪ **Activity Sector:**1) Commerce; 2) Service; 3) Industry 4) Construction ▪ **Time of Establishment (years):** 1) up to 2 years; 2) 2 to10 years; 3) 10 to 20 years; 4) above 20 years
Company Data
▪ **Active Employees:** 1) up to 10;2) from 11 to 20; 3) above 20 ▪ **Annual Revenue (Millions - R$):** 1) up to 1.2; 2) above 1.2t or 2.4; 3) above 2,4 to 3,6

Source: The Authors

Figure 1

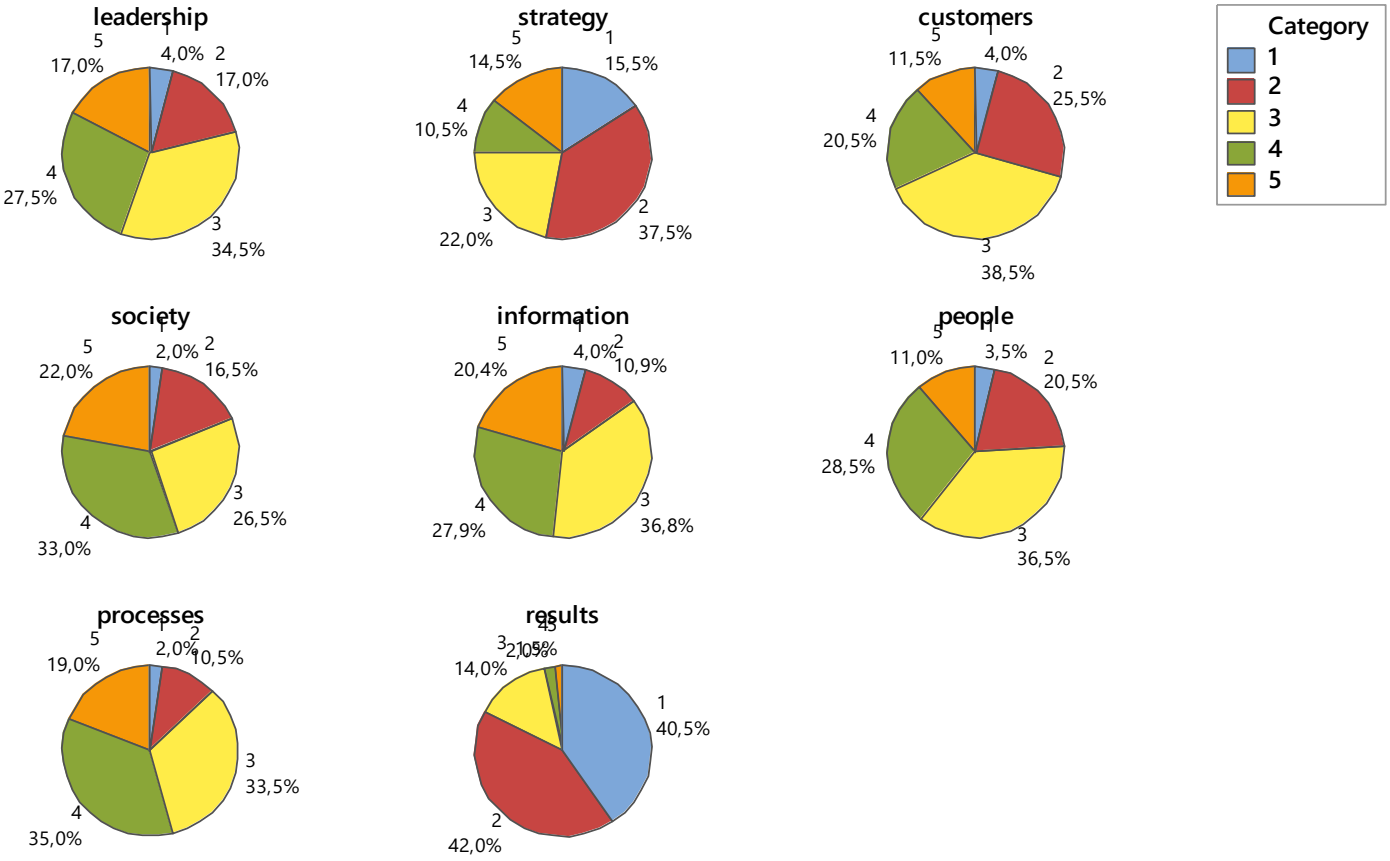
Characterization of SMEs



Source: The authors

Figure 2

Management factors of SMEs



Source: The authors

Table 7

Summary of the dependency analyses of the IV (Sociodemographic Factors)

Variables (Sociodemographic Factors)	Highest Average (Presented)	Financial Performance (SMEs of Barretos)
Gender	No Statistical Dependence	P-value = 0.645 > 0.05 (statistical independence)
Age	Above 30 up to 59 years	P-value = 0.001 < 0.05 (statistical dependence)
Previous Entrepreneurships	Has Undertaken Once	P-value = 0.003 < 0.05 (statistical dependence)
Education	Post-graduate/Master's Degree	P-value < 0.0001 < 0.05 (statistical dependence)
Sector of Activity	Industry and Construction	P-value = 0.037 < 0.05 (statistical dependence)
Time of Incorporation	Above 20 years	P-value = 0.004 < 0.05 (statistical dependence)
Number of Employees	From 11 to 20	P-value < 0.0001 < 0.05 (statistical dependence)
Revenue Range	2,400,000.00 to 3,600,000.00	P-value < 0.0001 < 0.05 (statistical dependence)

Source: The authors

In a first stage, a statistical analysis of the data was performed using the Chi-square tests of Independence between "sociodemographic IV" and "DV of financial performance". Hypothesis tests showed significant associations (dependence) between each factor and the financial performance of SMEs (1 = above average; 0 = below average). Table 7, corroborated with Figures 1 and 2, demonstrates the significant associations (p-value < 0.05) for the factors "Age", "Education", "Revenue Range", "Sector of Activity", "Number of Employees", "Time of Establishment" and "Experience with Entrepreneurship". The exception whose statistical analysis

did not indicate possible evidence of association (p-value > 0.05) was the factor "Gender". In a second step, a binary logistic regression (BLR) model was applied simultaneously involved all 16 IV related to the binary response (1 = above average; 0 = below average) of the financial performance of SMEs. For the case investigated, the results revealed that 7 (≅44%) of the 16 "managerial" and "non-managerial" factors investigated influence the performance (p-value < 0.05) of SMEs. Therefore, these results had significant effects on the probabilities of success (above average performance) of SMEs. The evidence of the BLR results for the covariates or IV ("People", "Processes", "Results", "Revenue", "Education", "Leadership and Innovation" and "Experience with Entrepreneurship") is presented in Table 8.

Table 8

Consolidated analysis using Binary Logistic Regression (BLR)

Management Factors	Types of Factors	Degrees of Freedom	Chi-square	P-value	Coefficient Estimator	S.E. Estimator's
Gender	Sociodemographic	1	0.94	0.333	-0.791	0.836
Previous Business	Sociodemographic	1	6.55	0.01	1.586	0.693
Education	Sociodemographic	1	8.36	0.004	1.427	0.582
Sector of Activity	Sociodemographic	1	0.83	0.362	0.452	0.506
Time of Establishment	Sociodemographic	1	1.25	0.264	-0.569	0.512
Number of Employees	Sociodemographic	1	2.4	0.121	-1.247	0.837
Revenue Range	Sociodemographic	1	24.96	< 0.001	3.91	1.11
Age	Sociodemographic	1	1.74	0.187	0.0404	0.0315
Leadership and Innovation	Managerial	1	8.05	0.005	1.663	0.65
Strategy	Managerial	1	0.71	0.401	0.379	0.457
Clients	Managerial	1	1.35	0.245	0.693	0.618
Society	Managerial	1	0.61	0.433	0.338	0.436
Informations	Managerial	1	2.63	0.105	0.847	0.547
People	Managerial	1	7.48	0.006	1.682	0.689
Processes	Managerial	1	19.52	< 0.001	2.873	0.888
Results	Managerial	1	28.4	< 0.001	3.292	0.91

Source: The authors

Table 8 shows that all maximum likelihood estimators of the BLR regression parameters associated with the significant FGEs (leadership and innovation, people, processes, and results with p-value < 0.05) are positive. Thus, we conclude that increases in the values of these covariates will result in increases in the probabilities of achieving above-average performance (greater chance of success) in SMEs. Considering the BLR model relating the eight covariates associated with Sociodemographic Factors to the probabilities of success (above-average performance), it is observed (Table 7) that three covariates (Education, Revenue Range, Number of times a business has already started) showed significant associations ("Dependence") (p-value < 0.05) with the financial performance of SMEs. The other covariates presented p-values > 0.05 (Age, Gender, Activity Sector, Time of Establishment, Number of Employees), that is, they are not statistically significant factors for SMEs.

It is possible to verify that the maximum likelihood estimators of all significant regression coefficients (p-value < 0.05) that simultaneously involved all 16 IV related to the financial performance response variable have positive signs. This indicates that an increase in each independent variable implies an increase in the probability of better financial performance for the DV. In particular, it was proven that management practices linked to "People", "Processes" and "Leadership and Innovation" are associated with better performance of SMEs. This result is in line with most studies that associate FGEs with better performance of SMEs. It is reasonable to assume that management practices linked to the factors mentioned lead to superior performance of these SMEs. This will be due to the nature of the management strategy adopted, that is, factors such as "People", "Processes" and "Leadership and Innovation" present a greater focus on the means than on the ends and even reveal a greater propensity for maturity of the managers of these SMEs. Spending energy on improving resources that support transformation processes raises the quality level of both managerial and operational processes and promotes a productive environment that is less susceptible to external variations in these SMEs. Examples include the research by Paulzen et al. (2002), York & Miree (2004), Matsumoto et al. (2015), Brito & Barbosa (2016), Garza-Reyes (2016), Motta et al. (2016), and Comfield & Mendes (2017). Most of these studies presented "Results" as the factor with the lowest contribution to MEGs and, consequently, with a negative impact on the performance of SMEs. However, the results obtained by this research showed that the managerial factor "Results" is the most significant for the MEGs of SMEs.

Conclusion

Competitiveness has become an essential requirement for survival in the business environments of Micro and Small Enterprises (MSEs) in Brazil. It is in this context that this research identified the Management Excellence Factors (MEFs), the sociodemographic factors and the degree of management maturity associated with the financial performance of MSEs in the city of Barretos (SP). The methodology applied was of an applied and quantitative nature through a survey and documentary analysis in conjunction with the use of statistical techniques and analyses of the data obtained from the MSEs. The survey data collection was carried out through the application of the MEG questionnaire from the National Quality Foundation (FNQ). The collection of documentary data was obtained from the registration database of the Brazilian Micro and Small

Enterprise Support Service (SEBRAE) of the city of Barretos. The analyses were carried out considering the degree of maturity, productivity, competitiveness and the eight MEFs (People, Customers, Processes, Strategy, Society, Information, Results and Leadership and Innovation) of the MEG. These analyses were also expanded to include eight other sociodemographic factors obtained from SEBRAE (Age, Gender, Education, Business Sector, Revenue Range, Time of Establishment, Number of Employees, and Experience with Entrepreneurship). The research analyzed a sample of 200 SMEs from different segments of specific sectors of Industry, Services, Commerce, and Civil Construction. Statistical analyses were applied through a descriptive analysis of the data and statistical tests (Chi-square of Independence and Binary Logistic Regression) using Minitab® software. The Independent Variables (IV) were defined based on the literature review and the MEG FGEs, while the Dependent Variable (DV) is the financial performance of the SMEs. The analyses demonstrated that the FGEs "People", "Processes", and "Leadership and Innovation" positively impact the financial performance of the SMEs (p-value <0.05). For sociodemographic factors, the results showed that the main sociodemographic factors are "Education" and "Experiences with Entrepreneurship".

In general terms, the literature has sought to understand the FGEs of SMEs using the "World Class" MEG. However, few studies have used MEGs to analyze the impact of FGEs on the performance of SMEs. There is a clear demand from managers to better understand the failures and success factors of SMEs. This research is therefore very relevant since SMEs need to develop because they are fundamental to the global economy and to Brazil. The mortality rate of these SMEs before the age of four is close to 77.9%, while they represent approximately 93.6% of private companies and are responsible for 30% of the GDP. In the Barretos region alone, there are 19.9 thousand active companies and approximately 90% are SMEs. Most of these SMEs are far from meeting the parameters of the current MEG and have an average productivity of only 30% compared to that of large companies in Brazil. Linked to this is the fact that more sophisticated management methods or tools are generally expensive and/or complex and are still beyond the reach of most SMEs. Therefore, this research is very significant because it fills a gap in literature and corroborates the practical reality of management in SMEs. This research brings relevant contributions to the understanding of FGEs and the development of more effective strategies to improve the financial performance and competitiveness of SMEs. Information on how the implementation of FGEs linked to "People", "Innovation", "Processes", "Leadership" and

"Results" are presented and can positively impact the financial performance of SMEs. In view of this, this research proves, to a degree of importance, the sequence of implementation of FGEs to be followed by SMEs. It also provides results that corroborate practical actions around the association between FGEs and the financial performance of SMEs both in the city of Barretos and in different regions of Brazil. This is very important because in Brazil, management problems are the main causes of the high mortality rates of SMEs. This issue, especially regarding effective innovations and competitiveness, has made managers aware of the importance of better understanding the human capital that comprises the SME ecosystem. It is essential to emphasize that innovation, by generating significantly greater production scale, is an important path to SME competitiveness. However, this requires planning and continuous coordination of resources (financial, human and technological) led by managers capable of integrating innovative attitudes into SME teams. Innovation linked to credibility and public recognition becomes an essential component of the strategic positioning adopted by SMEs. Improvements in processes, products and services (costs, quality, flexibility, productivity and competitiveness) can be obtained by adopting MEG. The conclusions demonstrated the use of MEG as a subsidy for the development of policies for SMEs. However, current MEGs do not unequivocally provide information of strategic relevance to SMEs. Furthermore, the limitations of this research are associated with the size and representativeness of the sample for only a small specific region of Brazil. Extending the research to other regions or countries with cultural and socioeconomic differences is opportune to consider generalizations, identify demands and improve MEGs for SMEs. Some suggestions for future research are: i) Including other variables and segments, ii) Expanding the time window to assess financial performance and iii) Applying this research to other regions and states of Brazil; iii) Conducting a critical assessment of the suitability of MEGs used in other countries for SMEs in Brazil.

Appendix

A.1. Chi-square Test of Independence

It is used to help determine whether the differences between the observed and expected values of certain categorical variables of interest indicate a statistically significant association between the variables, or whether the differences can simply be attributed to chance. In other

words, it is used to determine whether the value of one categorical variable depends on the value of the other categorical variable(s). In this type of hypothesis testing, the null and alternative hypotheses take the following form: i) H_0 – There is no statistically significant association between the two variables. ii) H_a – There is a statistically significant association between the two variables.

Although the chi-square statistics are defined similarly for both the test of independence and the test of goodness of fit, the expected value for the test of independence is calculated differently since it involves two variables instead of one. Let the two variables being tested be X and Y, so that X has i categories and Y has j categories. The number of combinations of the categories X and Y forms a contingency table having i rows and j columns. Since we are assuming that the null hypothesis is true and that X and Y are independent variables, the expected value can be calculated as $E_{ij}=n_i n_j/n$ where n_i is the total observed frequencies in the ith row, n_j is the total observed frequencies in the jth column and n is the sample size. Hence, $\chi 2$ is then defined as,

$$\chi^2 = \sum_{i=1}^{p} \sum_{j=1}^{q} (O_{ij} - E_{ij})^2 / E_{ij} \qquad \text{(A.1)}$$

where O_{ij} is the observed value in row i and column j, E_{ij} is the expected value in row i and column j, p is the number of rows, and q is the number of columns in the contingency table. Therefore, note that p represents the number of categories for one of the variables, while q represents the number of categories for the other variable. For a chi-square test of independence, the number of degrees of freedom of the asymptotic chi-square distribution is given by $df = (p - 1)(q - 1)$. Once the df is known, the critical value and critical region can be determined for the selected significance level, and the null hypothesis can be rejected or failed based on the results.

A.2. Binary Logistic Regression

A Binary Logistic Regression (BLR) model allows estimating the probability of a binary categorical response Y occurring with values 1 (success) or 0 (failure), as a function of one or more predictors or covariates (X), which may be continuous or categorical. A BLR can be interpreted as a complement to the usual linear regression applied to categorical variables based on a link

function, a generalization of the chi-square test or, in general, a particular case of the family of Generalized Linear Models (GLM), which implements a logit link. A BLR model is given by:

$$Y = \log[P/(1-P)] = \beta_0 + \beta_1 X_1 + \cdots + \beta_p X_k \qquad \text{(A.2)}$$

where P represents the probability of an event of interest occurring, $1-P$ represents the probability of the event of interest not occurring, $\log[P/(1-P)]$ represents a logit transformation considered as the dependent variable, β_0 is the intercept, β_j , j = 1,2, ..., k denote regression parameters associated with a set of covariates, $X_1, X_2, ..., X_k$. The regression parameters $\beta_0, \beta_1, ..., \beta_p$ are usually estimated by the maximum likelihood method.

The following assumptions are necessary:

- The data are random and representative of the population
- The dependent variable is dichotomous/binary.
- The predictors do not present a high correlation between each other.
- There is a linear relationship between continuous predictors and the logit of the event of interest.

In the logistic regression model (A.2), note that,

- The dependent variable (a logit transformation) is a function of P.
- The event of interest Y is assumed to be a random variable with a Bernoulli distribution.

These characteristics cause the results of the logistic regression to inform about chances (*Odds*) and Odds Ratio, and not about probabilities (*Risks*), directly.

Authors' contributions

Contribution	Guimieri, L.	Pinto, A. R. F.	Achcar, J. A.	Hermosilla, J. L. G.	Pinto, R. H. F.
Contextualization	X	X	---	X	X
Methodology	X	X	X	X	X
Software	---	---	X	---	---

Contribution	Guimieri, L.	Pinto, A. R. F.	Achcar, J. A.	Hermosilla, J. L. G.	Pinto, R. H. F.
Validation	X	X	X	X	X
Formal Analysis	X	X	X	X	X
Investigation	X	X	X	X	X
Resources	X	---	X	---	---
Data Curation	X	---	X	---	---
Original	X	---	---	X	X
Revision and Editing	---	X	---	X	X
Visualization	X	X	X	X	X
Supervision	---	X	---	X	---
Project Management	X	X	---	X	---
Obtaining Funding	---	X	---	X	---

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