

THE INFLUENCE OF PEOPLE MANAGEMENT PRACTICES ON A CULTURE OF LEAN MANUFACTURING

A INFLUÊNCIA DAS PRÁTICAS DE GESTÃO DE PESSOAS EM UMA CULTURA DE LEAN MANUFACTURING

Submission: 26/04/2021

Accept: 02/08/2022

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ABSTRACT

Purpose – This article aims to assess the perception of the influence of people management practices on the process of implementing a lean manufacturing culture.

Design/methodology/approach – The sample consisted of 303 respondents from five textile companies located in the southern region of Brazil, being collected by accessibility and convenience. Multiple regression analysis was used for data treatment and analysis.

Findings – As a result, the research showed that people management practices (recruitment and selection, retaining talent, people development, and work environment) influence the implementation of lean manufacturing in organizations. In contrast, the working contract practice did not show an influence on the implementation of lean manufacturing.

Research limitations/implications – The use of a certain market segment considering a cross-sectional view can be considered a limitation of the study, therefore, the data may not express the results that would be obtained if analyzed in different market segments.

Practical implications – Pragmatically, it can be considered that this research contributes so that the main organizational managers can choose the most appropriate people management practice during the process of implementing a lean manufacturing culture, that is, investing essentially in retention and employee training.

Originality/value – This study is relevant and contributes to the expansion of scientific studies about people management practices and the implementation of lean manufacturing. In addition, the study allows managers of textile organizations to understand the level of implementation of lean manufacturing, and which people management practices should be prioritized in the adoption of lean.

Keywords – People management practices. Lean manufacturing. Lean benchmarking.

RESUMO

Objetivo – Este artigo tem como objetivo avaliar a percepção da influência das práticas de gestão de pessoas no processo de implantação de uma cultura de manufatura enxuta.

Design/metodologia/abordagem – A amostra foi composta por 303 respondentes de cinco empresas têxteis localizadas na região sul do Brasil, sendo coletados por acessibilidade e conveniência. A análise de regressão múltipla foi utilizada para tratamento e análise dos dados.

Resultados – Como resultado, a pesquisa mostrou que as práticas de gestão de pessoas (recrutamento e seleção, retenção de talentos, desenvolvimento de pessoas e ambiente de trabalho) influenciam a implantação da manufatura enxuta nas organizações. Em contrapartida, a prática do contrato de trabalho não mostrou influência na implementação da manufatura enxuta.

Limitações/implicações da pesquisa – A utilização de determinado segmento de mercado considerando uma visão transversal pode ser considerada uma limitação do estudo, portanto, os dados podem não expressar os resultados que seriam obtidos se analisados em diferentes segmentos de mercado.

Implicações práticas – Pragmaticamente, pode-se considerar que esta pesquisa contribui para que os principais gestores organizacionais possam escolher a prática de gestão de pessoas mais adequada durante o processo de implantação de uma cultura de manufatura enxuta, ou seja, investindo essencialmente na retenção e treinamento dos funcionários.

Originalidade/valor – Este estudo é relevante e contribui para a ampliação dos estudos científicos sobre as práticas de gestão de pessoas e a implantação da manufatura enxuta. Além disso, o estudo permite aos gestores das organizações têxteis compreender o nível de implantação da manufatura enxuta, e quais práticas de gestão de pessoas devem ser priorizadas na adoção do lean.

Palavras-chave – Práticas de gestão de pessoas. Manufatura enxuta. *Benchmarking* enxuto.

1 INTRODUCTION

Organizations that want to create sustainable competitive advantage in dynamic markets must be prepared to implement significant changes in their operations (Noll, 2000). One of the critical points for successful change is the understanding of how employees and the organization itself perceive changes when exposed to a transition environment (McCallister 2004). In this sense, according to Vukadinovic *et al.* (2018), a proactive approach to people management practices in change processes is one of the most important elements of companies organized according to the principles of Lean manufacturing and process management.

The transition of a company to a Lean Manufacturing [LM] system should focus on how the practices of people management influence employees' engagement, leadership, and effectiveness in this process of change (Bessant & Francis, 1999). Biazzo and Panizzolo (2000) explained that a work perspective, based on the principles of lean manufacturing, depends a lot on organizational flexibility and employee involvement.

Organizations that adopt lean manufacturing practices also take care to educate and develop employees in the use of these practices. Martín and Marin-Garcia (2010) mention that people management practices are directly associated with the implementation of lean manufacturing principles and with organizational results. Having human resources with the desired level of competence, in harmony with the directions and dynamics planned for the implementation and development of Lean systems, is an essential precondition for achieving competitive advantages in increasingly demanding global markets (Hooi & Leong, 2017).

Although many organizations benefit from adopting the Lean principles of management, Araujo and Rentes (2005) argue the need for an adequate understanding of the Lean concept as a system, as many organizations have tried to import Japanese manufacturing techniques, but have not been success-



ful in the implementation process. Sezen, Karakadilar, and Buyukozkan (2012) express that neglecting socio-cultural factors in the process of changing to Lean philosophy limits the benefits achieved.

Given the entire set of characteristics of what is rational and logical for the implementation of lean manufacturing, from traditional benchmarking actions to daily operational activities, covering investments, costs, and process management, people management is a strategic part of the Lean philosophy. Lean manufacturing does not refer exclusively to the technical operations of an organization, but also to its strategic approach to people management practices (Wincel & Kull, 2016). According to Bellisario and Pavlov (2018), organizations that promote the Lean culture integrate the strategic and operational levels using people management practices, which stimulate organizational learning through employee commitment. Jasti and Kodali (2019) show in their research that employee commitment can be one of the essential characteristics to ensure a favorable result in the lean manufacturing implementation process.

Although there is a lot of research on people management and lean manufacturing, little is known about which of them influence the Lean culture during the implementation process (Beauvallet & Houy, 2010). In the same sense, Lucianetti *et al.* (2018) manifest the lack of knowledge about the set of people management practices established by organizations that adopt the Lean philosophy. Bevilacqua *et al.* (2017) express that in certain organizations, during the process of implementing the Lean culture, a restricted and insufficient set of management practices is used, reducing the benefits and operational performance, mainly influenced by the behavior of employees. Bocquet *et al.* (2019) consider the need to obtain a more unambiguous understanding of people management practices during the different stages in the course of implementing lean manufacturing. The organization needs to be assertive when defining the most appropriate practices for each stage to be implemented.

Longoni *et al.* (2013) show that the transition from the management of operational and business processes to the adoption of the Lean Manufacturing System requires a change in the way of managing employees, especially concerning the elaboration, effectiveness and monitoring of people management practices. According to Tortorella and Fogliatto (2014), there is an evident need to develop and carry out good people management practices, in order to develop and provide the human resources necessary for the implementation and operation of modern industrial systems, such as Lean Manufacturing. Tortorella and Fogliatto (2014) mention the extreme importance of recognizing these needs and understanding which practices meet the demands of the Lean philosophy.

Given the above, this article aims to assess the perception of the influence of people management practices on the process of implementing a lean manufacturing culture. Thus, the research is justified due to the need to understand and align people management practices in organizations that decide to change the traditional models of operational and business management, adopting new management models that contribute to improving performance, gaining competitiveness, and leveraging business in a sustainable manner (Cullinane *et al.*, 2014; Longoni *et al.*, 2013).

As a result, we found that people management practices (recruitment and selection, talent retention, people development, and work environment) influence the implementation of lean manufacturing in organizations. On the other hand, the practice of employment contracts showed no influence. Based on the results obtained, it is worth considering that during the lean manufacturing implementation process, it is noted that people management practices contributed to promoting the commitment of managers and consequently of all employees, instilling a mentality of promotion, reward, and retention, and attract high-performance practices, significant to explain the process of acculturation of the basic principles of Lean. Jasti and Kodali (2019) mention in their studies that employee commitment was one of the main characteristics of the successful implementation and acculturation of Lean principles.



2 LITERATURE REVIEW

2.1 People management practices

Organizations that need to remain competitive in the market seek to modernize and increase their ability to “[...] create knowledge, disseminate it in the organization, and incorporate it into products, services, and systems” (Nonaka & Takeuchi, 1995, p.12). For Kazan and Scorsolini-Comin (2010), due to changes characterized by economic phenomena, incorporation of new technologies, and new management practices, organizations need to be attentive to the identification, capture, and management of knowledge. Fitz-Enz (2010) understands that to grow and sustain the positions conquered by organizations, it is necessary to anticipate frequent changes in the business environment and adopt agile responses to decisions related to people management. This new market culture influences the change from traditional people management, moving away from the focus on bureaucratic issues and labor relations, towards strategic orientation, due to the need to improve organizational performance (Pavlov et al., 2017; Freitas, 2014).). In this context, Griffin (2011) highlights that the area of people management is essentially constituted by the respective policies, practices, and processes, which aim to provide organizations with trained professionals and perpetuate the high performance of employees.

According to Dutra (2016, p.17), “people management is a set of policies and practices that allow the reconciliation of expectations between the organization and people so that both can realize them in the long term.” For the author, policies are the guidelines, the principles that guide the behavior of people in organizations. Practices are the procedures, methods, and techniques used to implement decisions. In the same vein, Jabbour, Santos, and Nagano (2009) state that people management is a set of policies and organizational practices designed to influence the behavior of employees, guiding them towards the achievement of specific organizational objectives, through interaction between the people management area and the other organizational areas, in which people management is practiced daily, aiming at generating competitive advantages.

Through the concepts presented, Visser (2010) stands out, showing that people management must be shaped to the needs of the organization. These needs are constantly changing, and people management practices must permanently adapt to organizational changes. The convergence between people management practices and the organization’s needs, according to Jabbour et al. (2012), expresses a contemporary and strategic concept, where people management is recognized for its various projects, and a combination of practices aimed at improving organizational effectiveness.

Among the main challenges faced by professionals in the area of people management, Freitas (2014), and Freitas, Jabbour, and Santos (2011), highlight the management of organizational needs to the demands of the environment in which it operates. Although the basic concept of people management has remained stable in recent decades, Armstrong and Brown (2019) show that the area of human resources management has renewed and redirected the core elements of people management in organizations, instituting a holistic view of systems, individual and organizational structures, and practices. The authors show, from a strategic perspective, how the area of human resources management can better promote organizational objectives, an alignment of people management with organizational strategy, and the integration of people management practices with an emphasis on long-term benefits (Armstrong, 2020; McClean & Collins, 2019). For Soares (2012), managers who disregard the context in which the organization is inserted may face ethical dilemmas and behavioral crises in interpersonal relationships.

Given the adversities faced by managers when implementing people management practices in a given context, Martínez-Jurado, Moyano-Fuentes and Jerez-Gómez (2014), and Dewettinck

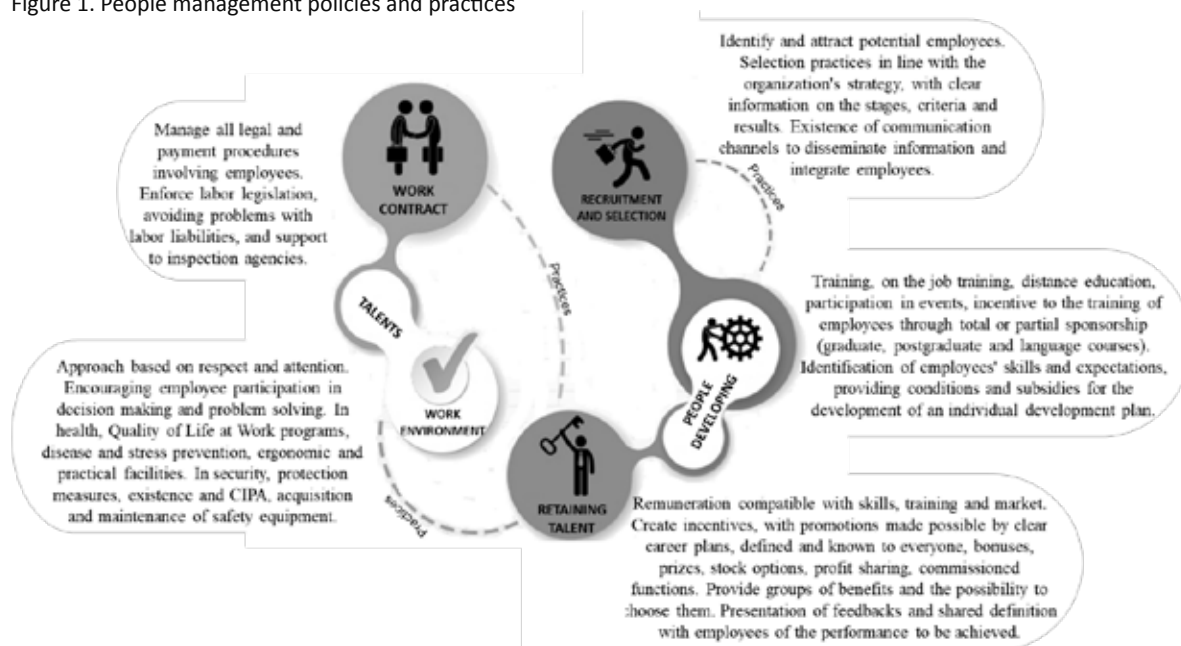


and Remue (2011), highlight that organizations must develop a new work culture, which emphasizes the role of employees, considering them as assets and not as a mere factor of production. According to Jabbour *et al.* (2012), and Visser (2010), the attitudes and behavior of employees are influenced by the configuration of the set of people management practices adopted in organizations.

Freitas (2014) and Freitas *et al.* (2011) point out that people management managers must adopt practices according to the organization's strategies. Thus, it is learned that practices and strategies must be aligned, transposing all levels of the organizational structure so that no mismatch could cause demotivation and unsatisfactory results. Given this, Narayan, Sidhu, and Volberda (2020) show that people management practices should provide organizations with the ability to develop and manage human capital to convey competitive advantage, as well as have a strategic focus, to incorporate technical or operational people management practices to pursue a high-performance work strategy.

For Schaurich (2014) and Demo (2011), people management policies should serve as a reference to enable the implementation of the organization's objectives and, thus, serve as a guide for actions in the area of people management. Schaurich (2014) portrays that people management policies are implemented in a series of practices directly related to them. The author points out that people management practices (Figure 1) correspond to the different procedures, methods, and techniques used to implement organizational decisions.

Figure 1. People management policies and practices



Source: adapted from Schaurich (2014).

For work management practices to permeate all hierarchical levels and work methods, Kianto, Sáenz, and Aramburu (2017) highlight that organizations must develop, implement and manage the main people management policies, procedures, and practices necessary for favorable, innovative, and lasting organizational culture.

2.2 Lean manufacturing

The concept of Lean Manufacturing [LM] was developed by a group of researchers from the Massachusetts Institute of Technology [MIT]. The definition was based on the management and manufacturing methods of the Toyota Production System [TPS], developed by Toyoda and Ohno (Liker, 2021). The Toyota Production System, originally from Japan, spread around the world quickly and efficiently due to the results presented, being of great representation for the automobile industry and which, later, was duly implemented for other manufacturing organizations (Jones & Womack, 2004).

According to Ohno (1988), lean manufacturing aims to eliminate waste and unnecessary elements, to reduce costs. The basic idea is that only what is needed is produced, at the necessary time, and in the required quantities. Shingo (2019) conceptualizes lean manufacturing as the search for a productive technology that uses the least amount of resources possible, aiming at the manufacture of products without defects, in the shortest imaginable time, minimizing intermediate units and eliminating waste. The author understands “waste” as any element that does not contribute to meeting the quality, price, and deadline required by the client.

Lean manufacturing is now understood as a synonym of good operational practices, applicable to the different areas of the organization (Gollan, Kalfa, & Xu, 2015). Freitas *et al.* (2014) emphasize that lean manufacturing is a philosophy focused on identifying and eliminating waste throughout the value chain, not only within the organization.

According to Martínez-Jurado *et al.* (2014), lean manufacturing is a management philosophy based on continuous improvement, which requires the involvement and commitment of all people in the organization, and provides an opportunity to improve results in terms of quality, costs, and delivery times. Shah and Ward (2002) emphasize that lean manufacturing involves a series of management practices, among which are the Just in Time [JIT] philosophy, the continuous improvement of processes, quality systems, cellular manufacturing, zero waste, etc.

The adoption of lean manufacturing in all areas of the organization, according to Longoni *et al.* (2013), requires a series of changes in people management, process design, and the way work is organized. Organizations that adhere to the Lean Manufacturing system must inevitably shift from traditional mass production models to new ones, reorganizing their work systems and people management practices.

The transition process to lean manufacturing, supported by people management practices, requires technical details about the roles that people must play during and after the implementation process, thus ensuring success in the adoption of the Lean Manufacturing system (Pedersen & Huniche, 2011; Turesky & Connell, 2010).

Barouch and Kleinhans (2015) mention that although most studies analyze the tangible aspects of lean manufacturing, it is also necessary to consider the acculturation of people with the Lean philosophy. According to the authors, one of the main facts of inefficiency in the process of implementing lean manufacturing is the non-adherence to Lean principles and practices by the organization’s employees, especially managers.

The commitment of top management, according to Raja Sreedharan *et al.* (2018), positively influences the implementation of lean manufacturing, providing support to the organization through the application of people management practices in the training and skills development of employees. Grigg, Goodyer, and Frater (2018) point out that a successful implementation of the Lean Manufacturing system depends essentially on people’s behavior and engagement associated with Lean management principles. These aspects must be used together to achieve sustainable results from the implementation of a lean manufacturing culture.

Based on the theoretical framework, the following hypotheses (Table 1) were proposed:



Table 1. Research hypotheses

H_1 : The practice of Recruitment and Selection influences the implementation of lean manufacturing;
H_2 : The practice of Retaining Talent influences the implementation of lean manufacturing;
H_3 : The practice of People Developing influences the implementation of lean manufacturing;
H_4 : The practice of Work Contract influences the implementation of lean manufacturing;
H_5 : The practice of Work Environment influences the implementation of lean manufacturing.

3 RESEARCH METHODOLOGY

The research is characterized as quantitative, by using indicators as a way to analyze dimensions, capturing data that indicate the functioning of the institutions (Lindfelt *et al.*, 2018). To measure people management practices, a questionnaire (Appendix 1) composed of 25 components was used, structured by a set of five dimensions, which are: Recruitment and Selection; Retaining talent; People development; Work contract, and Work environment (Table 2). The questionnaire was developed based on Foroni (2014), and Freitas (2014), evaluating people management practices in organizations. The Likert scale was adopted, measuring the degree of agreement and disagreement with statements (Curado, Teles, & Marôco, 2014). Each question in the questionnaire contains five answer options, ranging from (1) Strongly disagree and (5) Strongly agree.

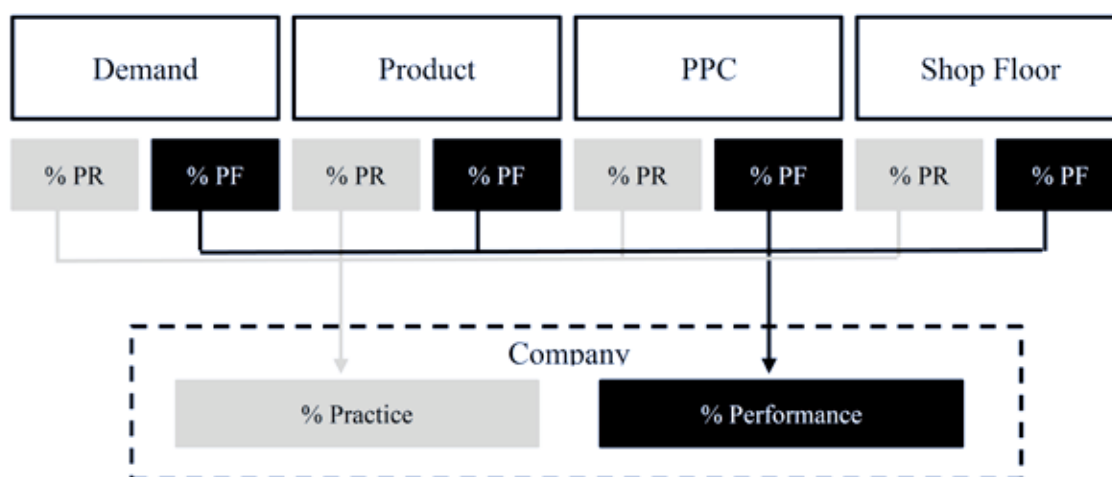
Table 2. Dimensions description

	Dimension	Description
People Management Practices	Recruitment and Selection	Create strategies to recruit and select professionals who are willing to get involved and commit to the activities developed in the organization (Freitas, 2014).
	Retaining talent	Financial reward programs or not, with the purpose of giving back, valuing, and stimulating the behaviors and actions of people who add value to the organization (Bohlander & Snell, 2014; Boudreau & Milkovich, 1999).
	People development	Promote and expand the acquisition of competencies, rules, concepts, or attitudes that result in better synergy between the characteristics of the people and the demands of organizational roles exercised (Freitas, 2014; Boudreau & Milkovich, 1999).
	Work contract	Manage the administrative and legal control processes, regarding the labor relations between employees and employers (Júnior, Morais, & Teixeira, 2013).
	Work environment	Environments constituted in people's behavior and engagement with established organizational practices, are conducive to human development, good interpersonal relationships, and well-being inside and outside the work environment (McClellan & Collins, 2011; Trentin <i>et al.</i> , 2016).
Lean Benchmarking	Demand	Understanding the basic characteristics of the quantity of goods or services that consumers want to purchase at a given price in a given market, over a certain time (Mas-Colell, Whinston, & Green, 1995, p.580-582).
	Product	Everything that can satisfy a desire or a need, is based on the design, packaging, distribution, price quality, and guarantee of the offered product (Mont, 2002).
	PPC	It provides the necessary conditions to support the decision-making process on what, how much, when, where, and how to produce or buy the inputs and products processed in the production system (Tubino, Poler, & Silva, 2011)
	Shop Floor	It investigates structures present in the organization, or department, that enable the effective transformation of primary inputs into semi-finished and finished products. It focuses on analyzing how human resources and physical infrastructure are being applied to achieve the desired results (Tubino, Poler, & Silva, 2011).



To better understand the implementation of lean manufacturing, we use the Lean Benchmarking [LBM] method (Appendix 2), created at the Production Systems Simulation Laboratory [LSSP] at the Federal University of Santa Catarina [UFSC]. This method aims to identify important requirements for the success of the implementation of lean manufacturing (Valle *et al.*, 2008). The LBM method consists of 37 Practices [PR] and Performances [PF] indicators, related to the dimensions: Demand (Sales); Product (Engineering); Production Planning and Control [PCP]; and Shop floor (Production and Assembly) (Table 1). The consolidation model of LBM results can be seen in Figure 2.

Figure 2. Consolidation of LBM results



Source: Valle *et al.* (2008).

The Lean Benchmarking method for data collection works with a scoring system ranging from 1 to 5, describing three situations for each item to be measured:

- a. Note 1 - is equivalent to a basic level of practice or performance. Considered 20% of the level of world-class companies;
- b. Note 3 - is equivalent to an intermediate level of practice or performance. Considered 60% of the level of world-class companies;
- c. Note 5 - is equivalent to excellence in practice or performance. Considered 100% of the level of world-class companies.

Based on this description, which serves as a parameter in choosing the note that best describes the organization's situation, notes 2 (40%) and 4 (80%) are used for intermediate positions in the evaluation of each item (Andrade, 2007). Valle *et al.* (2008) and Tubino *et al.* (2008) emphasize that organizations with indexes below 60% will deserve special attention concerning the implementation of lean manufacturing practices.

To obtain the data, an exploratory survey and the LBM method were carried out with a cross-section sample, with structured questionnaires made available for filling via the Internet. The sample consisted of 303 respondents from five companies in the textile segment, located in the

southern region of Brazil, being used by accessibility and convenience. It is noteworthy that the organizations surveyed were chosen because they were in the process of consolidating the lean manufacturing culture, with approximately between 12 and 24 months of implementing the practices. The survey data were collected between October 2020 and January 2021. Then the data were tabulated in a Microsoft Excel® spreadsheet and imported into the software SPSS® (Statistical Package for the Social Sciences) version 22.

Regarding the statistical technique used for the treatment and analysis of the data, descriptive research was used, indicating for detailing specific situations, in which it is developed and structured to measure the characteristics of the occurrences found in a scientific study (Hair Jr. *et al.*, 2009). Cronbach's Alpha reliability test was performed. According to Hair Jr. *et al.* (2009), this indicator measures reliability in a range from 0 to 1, with values from 0.60 to 0.70 being considered the lower limit of acceptability. Multiple linear regression was also applied. This multivariate analysis technique is used to explain or predict the occurrence of a given event based on a set of predictive dimensions (Fávero *et al.*, 2009).

4 RESULTS

To characterize the sample, demographic aspects were investigated. Table 3 shows a predominance of male respondents (76.24%) among the survey participants. Regarding the distribution of respondents by function, it is evident that 61.7% (coordinator and operational leader) occupy middle management positions. Most of the research participants have a technical school (47.2%), while the number of respondents with higher education and postgraduate degrees represents 42.2% of the sample.

Table 3. Distribution of respondents according to gender, education and function

Gender	Male		Female		
	231	76.2	72	23.8	
Education	Frequency	Percent	Function	Frequency	Percent
Postgraduate	39	12.8	Director	12	4.0
Higher education	89	29.4	Manager	34	11.2
Technical school	143	47.2	Coordinator	31	10.2
High school	32	10.6	Operational Leader	156	51.5
-	-	-	Area Specialist	70	23.1
Total	303	100.0	Total	303	100.0

After completing the analysis of the distribution of respondents, a descriptive analysis of the sample was carried out. Table 4 shows the average values of each dimension by researched company. As we can see, it is observed that the highest average value obtained among people management practices is the dimension of talent retention, with an average value of 4.02 in Company 5, while the lowest average score of 2.64 belongs to the dimension of work environment, in the Company 1. Regarding the LBM, it can be seen that the mean values of the dimensions were practically around 3.



Table 4. Descriptive analysis

Dimension		Organization											
		Company 1		Company 2		Company 3		Company 4		Company 5		All	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Macro Dimension	People Management Practices												
	Recruitment and selection	2.68	0.630	2.88	0.504	2.91	0.611	3.22	0.637	3.42	0.486	3.02	0.634
	Retaining talent	2.68	0.772	2.81	0.608	3.21	0.808	3.44	1.100	4.02	0.454	3.24	0.911
	People developing	2.91	0.494	3.08	0.425	3.08	0.709	3.29	0.636	3.08	0.559	3.08	0.578
	Work contract	2.83	0.562	2.97	0.479	3.17	0.608	3.35	0.731	3.73	0.338	3.22	0.639
	Work environment	2.64	0.708	2.85	0.714	3.07	0.637	3.36	0.825	3.79	0.430	3.15	0.787
	Total	2.75	0.491	2.92	0.371	3.09	0.524	3.33	0.665	3.61	0.325	3.15	0.576
	Lean Benchmarking												
	Demand	2.99	0.510	3.06	0.519	2.85	0.662	3.29	0.581	2.90	0.452	3.01	0.561
	Product	2.79	0.538	3.05	0.440	3.01	0.498	3.30	0.682	2.90	0.428	3.00	0.546
PCP	3.80	0.694	3.92	0.604	3.69	0.578	3.85	0.582	3.75	0.527	3.80	0.601	
Shop floor	2.84	0.513	3.04	0.416	2.83	0.497	3.17	0.612	2.89	0.423	2.95	0.509	
Total	3.12	0.430	3.28	0.280	3.09	0.352	3.43	0.407	3.19	0.280	3.22	0.373	
Number of respondents		65		58		55		57		68		303	

We also proceeded to verify if there is an alternation between dimensions through the average values attributed to people management practices and LBM indicators by surveyed company. The data were tested for normality, using the Shapiro-Wilk test, but the results revealed that they are not normally distributed. According to Hair *et al.* (2011), when data are measured by ordinal or nominal scales, the assumption that the data are normal is not always valid. In these cases, the use of non-parametric tests is suggested. Thus, we used the Wilcoxon-Mann-Whitney test for two independent samples. The Wilcoxon-Mann-Whitney test was used to determine whether the differences in average values attributed to people management practices and LBM indicators between the five companies surveyed are statistically significant. The analysis was performed in pairs, according to Table 5.



Table 5. Wilcoxon-Mann-Whitney test: company surveys by dimension

Wilcoxon-Mann-Whitney (U test)		Macro Dimension								
		People Management Practices					Lean Benchmarking			
		Dimension					Dimension			
		Recruitment and selection	Retaining talent	People developing	Work contract	Work environment	Demand	Product	PCP	Shop floor
Company 1 and Company 2	Result	≠ AV	≅ AV	≅ AV	≅ AV	≅ AV	≅ AV	≠ AV	≅ AV	≠ AV
	p-value	0.037	0.255	0.055	0.201	0.084	0.820	0.003	0,538	0,029
	U test	1476.0	1661.5	1517.5	1634.5	1545.0	1841.0	1297.0	1764.5	1457.5
Company 1 and Company 3	Result	≠ AV	≠ AV	≅ AV	≠ AV	≠ AV	≅ AV	≅ AV	≅ AV	≅ AV
	p-value	0.022	0.001	0.328	0.004	0.001	0.111	0.051	0.170	0.457
	U test	1356.0	1151.5	1606.5	1248.5	1142.5	1487.5	1421.5	1528.5	1647.0
Company 1 and Company 4	Result	≠ AV	≠ AV	≠ AV	≠ AV	≠ AV	≠ AV	≠ AV	≅ AV	≠ AV
	p-value	0.000	0.000	0.001	0.000	0.000	0.007	0.000	0.845	0.008
	U test	989.0	1092.0	1196.0	1095.5	947.5	1333.5	1097.0	1814.5	1335.0
Company 1 and Company 5	Result	≠ AV	≠ AV	≅ AV	≠ AV	≠ AV	≅ AV	≅ AV	≅ AV	≅ AV
	p-value	0.000	0.000	0.236	0.000	0.000	0.165	0.189	0.160	0.942
	U test	762.5	334.0	1954.0	325.0	423.0	1904.0	1924.0	1899.5	2194.0
Company 2 and Company 3	Result	≅ AV	≠ AV	≅ AV	≅ AV	≅ AV	≅ AV	≅ AV	≠ AV	≠ AV
	p-value	0.601	0.007	0.444	0.070	0.083	0.057	0.510	0.039	0.006
	U test	1504.5	1128.0	1465.0	1281.0	1294.0	1267.5	1481.0	1237.0	1121.5
Company 2 and Company 4	Result	≠ AV	≠ AV	≠ AV	≠ AV	≠ AV	≅ AV	≅ AV	≅ AV	≅ AV
	p-value	0.001	0.002	0.037	0.002	0.001	0.072	0.095	0.386	0.425
	U test	1062.5	1090.0	1286.0	1099.5	1069.0	1333.5	1356.5	1498.5	1511.0
Company 2 and Company 5	Result	≠ AV	≠ AV	≅ AV	≠ AV	≠ AV	≅ AV	≠ AV	≠ AV	≠ AV
	p-value	0.000	0.000	0.603	0.000	0.000	0.137	0.038	0.045	0.028
	U test	887.0	256.0	1868.5	358.0	550.5	1672.0	1553.5	1563.5	1527.5
Company 3 and Company 4	Result	≠ AV	≅ AV	≠ AV	≅ AV	≠ AV	≠ AV	≠ AV	≅ AV	≠ AV
	p-value	0.007	0.171	0.030	0.155	0.046	0.000	0.034	0.183	0.002
	U test	1105.0	1333.0	1201.0	1324.5	1225.5	878.0	1205.0	1339.0	1039.5
Company 3 and Company 5	Result	≠ AV	≠ AV	≅ AV	≠ AV	≠ AV	≅ AV	≅ AV	≅ AV	≅ AV
	p-value	0.000	0.000	0.971	0.000	0.000	0.511	0.255	0.731	0.342
	U test	993.0	766.5	1863.0	831.0	652.0	1741.5	1648.5	1802.5	1684.0
Company 4 and Company 5	Result	≅ AV	≠ AV	≠ AV	≠ AV	≠ AV	≠ AV	≠ AV	≅ AV	≠ AV
	p-value	0.185	0.044	0.045	0.014	0.005	0.000	0.001	0.318	0.008
	U test	1672.5	1534.5	1541.0	1447.0	1372.5	1177.0	1267.0	1737.0	1403.0

Captions: ≠ (Difference); ≅ (Similarity and or equality); AV (Average value)



In the Wilcoxon-Mann-Whitney (U) test, p-value values less than 0.05 demonstrate that the groups are significantly different. In this case, there is a statistically significant difference (p-value <0.05) between the companies surveyed, especially among people's management practices. As for LBM, 60% showed similarity in the average values presented.

The reliability of the dimensions was assessed using the Cronbach's Alpha test (Table 6). According to Hair Jr. *et al.* (2009), this indicator measures reliability in a range from 0 to 1, with values from 0.60 to 0.70 being considered the lower limit of acceptability. In this research, the values were considered to have good data reliability.

Table 6. Reliability analysis

Macro Dimension	Cronbach's α	Number of items
People Management Practices	0,892	25
Lean Benchmarking	0,826	37

Through the KMO test (Kaiser-Meyer-Olkin - Measure of Sampling Adequacy) that determines the sample adequacy concerning the degree of partial correlation, ranging from 0 to 1, it is noticed that KMO close to 1 indicates that it is very suitable for use of the Factor Analysis [FA] technique. In contrast, values close to 0 reflect a weak correlation between dimensions. It is noteworthy that for the correct use of FA the KMO must be at least 0.6 (Fávero *et al.*, 2009; Hair Jr. *et al.*, 2009). Therefore, the KMO test showed reasonable explanatory power (0.725), as highlighted in Table 7. In turn, Bartlett's sphericity test presented a p-value of 0.000, indicating that there is a correlation between dimensions, so it is advisable to use FA (Table 7). It is evident that for the p-value to be significant it must be below 0.05 (Fávero *et al.*, 2009; Hair Jr. *et al.*, 2009).

Table 7. KMO and Bartlett's tests in dimensions 1 to 9

KMO e Bartlett's test		
Kaiser-Meyer-Olkin measure of sampling adequacy.		.725
	Approx. Chi-square	1155.686
Bartlett's sphericity test	Df.	36
	Sig.	.000

Five components were loaded into each of the dimensions of people management practices (Recruitment and selection; Retaining talent; People development; Work contract; Work environment). Eight components were loaded in the Demand dimension, eight components in the Product dimension, ten components in the PCP dimension, and eleven components in the Shop Floor dimension. The factor analysis of the statements confirmed five dimensions for the scale of people management practices and four dimensions for the Lean Benchmarking method. The analysis produced 02 factors depicted in Table 8. The two joint factors in this study contributed to 58.89% of the total variance.



Table 8. Rotating component matrix

	Factor		Variance	
	1	2	Variance (%)	Accumulated (%)
Retaining talent	.894			
Work contract	.887			
Work environment	.846		38.765	38.765
Recruitment and selection	.815			
People developing	.607			
Demand		.793		
Product		.679	20.126	58.891
PCP		.628		
Shop floor		.518		

Extraction Method: Principal component analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Converged rotation in 3 iterations.

The results of Practices [PR] and Performances [PF] are shown in Table 9.

Table 9. Lean Benchmarking by Company

Dimension	Lean Benchmarking (%)										LBM Reference (%)
	Company 1		Company 2		Company 3		Company 4		Company 5		
	PR	PF	PR	PF	PR	PF	PR	PF	PR	PF	
Demand	41	73	40	74	47	63	40	70	47	69	
Product	49	73	49	68	52	68	48	74	51	64	
PCP	76	81	75	83	71	82	78	80	70	75	60
Shop floor	63	60	61	57	60	54	60	58	60	57	
General indicator	57	72	56	70	58	67	57	70	57	66	60

Captions: PR (Practice); PF (Performance).

Table 9 shows that companies, in general, are found with the indicator Practice between 56% and 58% of adequacy, considered a basic level of performance, limited to the minimum necessary to reach the intermediate level for world-class companies. The general performance indicator, showing percentages between 66% and 72%, is at the minimum performance level necessary to reach the intermediate level of world-class companies. Kolberg and Zühlke (2015) mention that the basic implementation of lean manufacturing alone is not enough to guarantee the transition process from a traditional organization to a lean philosophy. Netland (2016) evidences in his research that despite the good results in the implementation of lean manufacturing in the initial phase, it is necessary to expand, and therefore maintain, practices and performance at levels of excellence.

To identify the existence, or not, of a relationship between the dimensions surveyed, a multiple linear regression analysis was performed for each dimension, considering lean manufacturing as a dependent variable, and the dimensions' Recruitment and selection, Retaining talent, People development, Work contract and Work environment (people management practices) as independent variables.

The hypotheses of the relationship between the dimensions and their respective results are shown in Table 10.



Table 10. Multiple regression analysis

Hypotheses	β	p-value	Situação
H_1 : The practice of Recruitment and Selection influences the implementation of lean manufacturing;	0,462	0,000	Hypothesis not rejected
H_2 : The practice of Retaining Talent influences the implementation of lean manufacturing;	-0,201	0,026	Hypothesis not rejected
H_3 : The practice of People Developing influences the implementation of lean manufacturing;	0,320	0,000	Hypothesis not rejected
H_4 : The practice of Work Contract influences the implementation of lean manufacturing;	0,105	0,232	Hypothesis rejected
H_5 : The practice of Work Environment influences the implementation of lean manufacturing.	-0,209	0,009	Hypothesis not rejected

Adjusted $R^2 = 0.256$; $p < 0.05$.

It is observed that the dimensions showed a positive and negative relationship (β values). The relationship between the dimensions of Recruitment and selection ($\beta = 0.462$), People development ($\beta = 0.320$), and the implementation of lean manufacturing have a positive character. Such findings seem to indicate that the implementation of lean manufacturing is favorably influenced by the structured management and development of people's skills. Recruitment and Selection, of the five practices, is the one with the greatest influence capacity. The Talent Retention ($\beta = -0.201$) and Work Environment ($\beta = -0.209$) dimensions have a negative beta value, revealing that the absence of both practices negatively influences the implementation of lean manufacturing, demonstrating that organizations that do not have compensation, career plan, and specific benefits, in addition to a favorable work environment, can make the process of implementing lean manufacturing unfeasible. Table 10 shows that all values that tested the causal relationship between the dimensions, and the implementation of lean manufacturing, are within the parameters proposed by Hair Jr. *et al.* (2016), which confirms the hypotheses proposed in this research, except for hypothesis 4.

5 DISCUSSION

The effectiveness of a set of people management practices allows people to consider themselves stimulated and motivated to carry out their activities, satisfying their desires and needs and, concomitantly, fulfilling organizational objectives, namely the implementation of management principles of lean production and business processes. According to Treville and Antonakis (2006), the implementation of lean manufacturing must be carried out through a set of interrelated concepts and practices, which are reinforced, including continuous improvement, total quality management [TQM], total productive maintenance [TPM], design for manufacturing and assembly, Just In Time [JIT], supplier management, and in particular, effective people management.

It was observed that people management practices (recruitment and selection, retaining talent, people development, and work environment) are fundamentally related to the implementation of lean manufacturing in textile organizations. However, for the benefits of this relationship to be sustainable in the long term, the use of practices must be adopted as soon as possible by organizations. Bonavia and Marin-Garcia (2011) show in their studies that organizations that make the most of Lean management principles are also those that establish close relationships between Lean practices and people management practices. According to the authors, the combination of Lean practices and people management reduces inventories and increases productivity.

In addition, a favorable combination of Lean practices and people management can: create a more assertive route to hiring, minimizing possible mistakes in the recruitment process, allowing



new employees to start working faster; using Lean philosophy to develop training programs and improvement activities; utilize various performance metrics and efficiency strategies; and apply the lean philosophy to reveal ways to better educate employees about its benefits – increasing participation, improving well-being, and increasing return on investment. Ahuja *et al.* (2019), and Trollman and Colwill (2020), show that effective people management practices must permeate all organizational levels to ensure employee engagement, which is considered critical in the adoption of lean and sustainable manufacturing practices.

The diffusion of lean manufacturing principles through people management practices during the implementation process (transition from traditional operational management to Lean philosophy), influences people's experiences through learning, leveraging them as a source of competitive advantage. It highlights the importance of development to supply the organization with trained professionals, to guarantee qualified labor to assume current and future positions, to develop new skills, and to result in superior performance. The study by Martínez-Jurado *et al.* (2014) mentions the need to establish and strengthen links between operations management and people management, having fundamental connections during the processes of change. Martínez-Jurado *et al.* (2014) explain in their research that good management of people management practices contributes to overcoming attitudes of denial and resistance of employees in the process of implementing the Lean management principles.

In this sense, for employees to demonstrate higher levels of competence, commitment, and performance, it is necessary to guarantee the synergy between people management and lean manufacturing. To ensure the implementation of lean manufacturing, Freitas *et al.* (2014) state that the adoption of Lean principles requires a more humanized way of managing operations, through people management practices. According to Gollan *et al.* (2015), the transition of organizations to Lean management principles is facilitated when people management practices are effectively adopted by line managers. For the authors, the responsibility of people management must be strengthened with the line managers through the strategies of the people management area.

Finally, it is considered that people management practices contribute positively to the implementation of lean manufacturing, revealing the importance of the human side in organizations. It is also understood the need for organizations to recognize the importance of people management during the transition process, thus expanding the synergy between the two areas of knowledge, people management, and lean manufacturing. In this sense, Trentin (2017) stands out that people management practices contribute positively to the implementation of lean manufacturing, revealing the importance of the human side in organizations. People management practices by organizations must be fundamentally related to the implementation of lean manufacturing so that the benefits of lean philosophy are sustainable in the long run.

5 CONCLUSIONS

The present study aimed to assess the perception of the influence of people management practices on a lean manufacturing culture. The companies surveyed are, in general, adequate to the minimum required performance level of 60% for the implementation of lean manufacturing, reaching the intermediate level of the practice and performance indicators of world-class companies, according to the Lean Benchmarking method [LBM].

The result of the H_4 hypothesis did not confirm the influence of the practice of "Employment Contract" on the lean manufacturing culture. The conclusion of the test of hypotheses H_1 , H_2 , H_3 , and H_5 showed the people management practices of Capture, Retention, Development, and Work Environment influence the lean manufacturing culture.



People management practices must be considered essential for the successful implementation of a lean manufacturing culture. Regarding the main people management practices evidenced in the present research, the Retention dimension stands out, which obtained the highest total average value among all people management practices, especially regarding the establishment of individual performance metrics and/or teams aligned with the company's goals, and the training of employees highlighted by potential and superior performance to become eligible for leadership positions in the succession plan. Regardless of the practice of Employment Contract did not show any influence in the implementation of lean manufacturing, we understand the importance of this practice to safeguard the transparency and legality of the procedures performed in the personnel administration area, thus ensuring compliance with legal obligations in force.

From this research it is inferred that organizations, through the people management area, must adopt ways of approaching issues related to the implementation of a lean manufacturing culture, using properly established people management practices, to create targeted approaches, respecting power structures and the diversity of personal and professional profiles.

Pragmatically, it can be considered that this research contributes so that the main organizational managers can choose the most appropriate people management practice during the process of implementing a lean manufacturing culture, that is, investing essentially in retention and employee training. The study contributes to the literature on lean manufacturing and people management, making it possible to discern which are the best practices in people management chosen by organizations of similar sizes to complement their lean manufacturing strategy and practices.

As a recommendation for further studies, it is suggested that this research be replicated in other market segments. After all, the results found in this research cannot be generalized, and its application and expansion in other areas, with different characteristics, would contribute to the theoretical and empirical understanding and maturation on the subject, since the praxis of people management is constantly evolving.

The results of this research comprise contributions for researchers, professionals, organizations, universities, and research institutions. This study provides an understanding for scholars who want to understand the importance of people management and its relationship with other areas of knowledge.

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Appendix 1. QUESTIONNAIRE - People Management Practices

Dimension Recruitment and selection		Description of Practices / Affirmations
R&S-01	External and internal capture	Does it carry out a formal competency-based recruitment and selection process (CHA) for the allocation and movement of employees?
R&S-02	Social networks	Are social networks used as a complementary tool in the selection process, in order to increase the volume of candidates and the possibility of anticipating information about the behavior of candidates through profiles on the networks?
R&S-03	Integration Program	Does it offer employees an introductory course (integration) to better adapt to the organization's culture, policies and regulations?
R&S-04	Adaptation Program (experience contract/ change of position)	Does it offer introductory or training courses for new employees and training in the event of internal movement?
R&S-05	Dismissal interview	Does it carry out actions (dismissal interviews) to identify the causes of voluntary dismissals/exonerations, adopting practices to increase the employee retention rate?



Dimension Retaining talent		Description of Practices / Affirmations
RET-01	Fixed Remuneration	Does it homogenize and standardize wages, facilitating internal balance (consistency of wages within the organization) and external balance (consistency of organization wages compared to market wages)?
RET-02	Variable Remuneration	Does it run an award/bonus program (recognition for high performance) in line with organizational goals and the interests of employees?
RET-03	Benefit Plan	Does it have a set of quality benefit programs or plans offered as a complement to the remuneration system (eg Health Insurance, Life Insurance, Food, Scholarship, Agreements, etc.)?
RRET-04	Performance Metrics	Does it establish individual and/or team performance metrics aligned with the organization's goals?
RET-05	Succession Plan	Does it prepare employees, highlighted by potential and superior performance, enabling them to occupy key positions, thus ensuring back up to strategic positions?
Dimension People developing		Description of Practices / Affirmations
PED-01	Technical/Operational Training/On the Job Training	Does it train and/or guide the workforce in relation to knowledge sharing and diffusion? Do you carry out a knowledge management process, documenting and sharing knowledge with employees?
PED-02	Formal Education / Fellowship Program	Does it develop a succession process for leadership positions, offering training and competence development programs that meet the needs of each management level (from operational to strategic), including potential leaders?
PED-03	PDE/I - Team or Individual Development Program	Does it establish partnerships between the people management area and the other areas of the organization, aiming at the development, solutions and services to meet the development needs of teams and people (eg identified performance/competencies gaps)? Does it carry out a process to evaluate the results of training and development actions and assess whether they have eliminated or reduced identified performance/competence gaps?
PED-04	Internal Communication	Performs communication actions to share the organizational strategic plan and other information/documents related to it with all employees?
PED-05	Internship / Trainee / Apprenticeship Program	Does it contribute to the Educational System, through the educational institutions with which it maintains close cooperation, in the training of future professionals, integrating actions and exchanging information with the technical/academic environment, regarding professional training?
PED-06	Performance Assessment	Identifies individual training needs when evaluating performance of employees, taking them into account in subsequent assessments? Do you train all members of senior management and other managers in performance management?



Dimension Work contract		Description of Practices / Affirmations
WOC-01	Admissions/Dismissals (professional registration)	Does it ensure compliance by the organization with all labor obligations related to the area?
WOC-02	Payroll (Vacation/Terminations /Payroll/Time Control) and Taxes	Does it perform internal and/or external payroll processing? Do you record (point card) and pay the amount of remuneration, discounts or rebates, net value to which each employee is entitled? Do you make the accounting entries of expenses with salary, social charges levied such as Social Security Contribution (INSS), Income Tax (IR), and the Guarantee Fund for Time of Service (FGTS)? Does the collection/payment of state and federal taxes comply with the provisions of current legislation?
WOC-03	Audit	Does it carry out internal and/or external audits periodically on the payroll?
WOC-04	Union Negotiation	Does it mediate understandings and negotiations with professional bodies, evaluating their meaning and implications, in the search for results that, in terms of cost/benefit, can meet the demands of employees and protect the interests of the organization?
WOC-05	Labor Processes	Does it submit the processes of recognition of the right/advantage of employees to the prior pronouncement of the legal area and senior management?
Dimension Work environment		Description of Practices / Affirmations
WOE-01	Climate/Opinion Survey	Does it collect data (e.g., interviews with employees, organizational climate surveys, employee opinion surveys) to verify that members of senior management and other managers demonstrate effective skills in managing organizational resources? Does it check the opinion of employees regarding the work environment and use the results to guide eventual changes?
WOE-02	Occupational Health and Safety	Does it carry out a process to identify and report to any consultative or deliberative body (e.g., Occupational Hygiene Committee, CIPA, etc.) any risks related to human resources, so that measures are taken to mitigate risk situations?
WOE-03	Quality of Life at Work	Evaluate the costs and benefits of quality-of-life programs, verifying whether they are contributing to the achievement of employee retention goals? Does it promote quality of work life programs and allocate necessary resources to establish and sustain these programs? Does it check the opinion of employees regarding the work environment and use the results to guide eventual changes?
WOE-04	Community Relationship	Does it invest in relationship actions that bring benefits to the community and employees, in addition to generating gains for the internal environment and in the perception that customers have of the company itself?

Fonte: adapted from Foroni (2014) and Freitas (2014).



Appendix 2. Lean Benchmarking [LBM] method

Demand indicator		Description of the scores
DEM-01	Demand forecast model	Score 1 - Company does not have a formal model to forecast demand and uses only the experience of the sales staff to forecast main items. Score 3 - Company has a formal model to forecast demand, with software, but only makes the forecast for main items. Score 5 - Company has a formal model to forecast demand, with software, and makes the forecast for all items.
DEM-02	ABC management of demand	Score 1 - Company does not have a formal model for ABC management of demand. Score 3 - Company has, and eventually uses, a formal model for ABC management of demand, with software. Score 5 - Company has, and always uses, a formal model for ABC management of demand, with software.
DEM-03	Market analysis	Score 1 - Company does not have a formal model for communication channel with the main customers. Score 3 - Company has, and eventually uses, a formal model for communication channel, with software and other techniques, for the main customers. Score 5 - Company has, and always uses, a formal model for communication channel, with software and other techniques, for the main customer.
DEM-04	Forecast reliability	Score 1 - Company misses more than 40% of demand forecast. Score 3 - Company misses between 20% and 30% of demand forecast. Score 5 - Company misses less than 10% of demand forecast.
DEM-05	Concentration degree	Score 1 - Company does not have demand concentration. Score 3 - Company has more than 50% of the demand at less than 30% of items. Score 5 - Company has more than 50% of the demand at less than 10% of items.
DEM-06	Frequency degree	Score 1 - Company has less than 20% of items with monthly sales frequency. Score 3 - Company has between 30% and 40% of items with monthly sales frequency. Score 5 - Company has more than 50% of items with monthly sales frequency.
DEM-07	Confirmed demand degree	Score 1 - Company has less than 20% of confirmed demand before beginning production. Score 3 - Company has between 40% and 30% of confirmed demand before beginning production. Score 5 - Company has more than 50% of confirmed demand before beginning production.
DEM-08	Demand response	Score 1 - PPC of company accesses the information of demand forecast, or confirmed orders in advance of the promised delivery date. Score 3 - PPC of company accesses the information of demand forecast, or confirmed orders, in advance of, or equal to, the promised delivery date. Score 5 - PPC of company accesses the information of demand forecast, or confirmed orders, after the promised delivery date.



Product indicators		Description of the scores
PRO-01	Concurrent Engineering	Score 1 - Company does not have a formal multifunctional model to design new products. Score 3 - Company has a formal multifunctional model to design new products, supported by an efficient communication channel. Score 5 - Company has a formal multifunctional model to design new products, supported by an efficient communication channel, which involves suppliers and final consumers.
PRO-02	Parameter setting of design	Score 1 - Company does not use parameter setting of design Score 3 - Company uses parameter setting of design for a few product families. Score 5 - Company systematically uses parameter setting of design for all product families.
PRO-03	Calendar of product development	Score 1 - Company does not have a calendar of product development. Score 3 - Company has a calendar of product development for a few items. Score 5 - Company has a calendar of product development for all items.
PRO-04	Special order negotiation	Score 1 - Company accepts special orders, despite parameter setting of design. Score 3 - Company accepts special orders, if they partially adhere to the parameter setting of design. Score 5 - Company accepts special orders, if they totally adhere to the parameter setting of design.
PRO-05	Internal defects percentage	Score 1 - Company has, on average, more than 0.1% defects, which means more than 10,000 parts per million. Score 3 - Company has, on average, less than 0.1% defects, which means less than 1,000 parts per million. Score 5 - Company has, on average, less than 0.1% defects, which means less than 1,000 parts per million.
PRO-06	Variety degree	Score 1 - In the portfolio of the company, the average ratio between the number of families and the number of items within these families is greater than 100. Score 3 - In the portfolio of the company, the average ratio between the number of families and the number of items within these families is between 50 and 100. Score 5 - In the portfolio of the company, the average ratio between the number of families and the number of items within these families is lower than 100.
PRO-07	Life cycle	Score 1 - If the rate between the portfolio lifetime and its programming cycle is lower than 4. Score 3 - If the rate between the portfolio lifetime and its programming cycle is between 6 and 10. Score 5 - If the rate between the portfolio lifetime and its programming cycle is greater than 10.
PRO-08	Leftover percentage	Score 1 - If the leftover percentage of the portfolio items is greater than 20%. Score 3 - If the leftover percentage of the portfolio items is between 5% and 10%. Score 5 - If the leftover percentage of the portfolio items is lower than 1%.



PPC indicators		Description of the scores
PPC-01	Master Production Planning (MPP)	Score 1 - Company does not have a formal Master Production Planning (MPP) model. Score 3 - Company has, and uses monthly, a formal Master Production Planning (MPP) model with software. Score 5 - Company has, and uses weekly, a formal Master Production Planning (MPP) model integrated to the Enterprise Resource Planning (ERP).
PPC-02	Material Requirement Planning (MRP)	Score 1 - Company does not have an MRP integrated system, but works with spreadsheets or isolated systems. Score 3 - Company has, and uses monthly, an MRP integrated system, with software. Score 5 - Company has, and uses weekly, a formal MRP system integrated to the Enterprise Resource Planning (ERP).
PPC-03	Production capacity analysis	Score 1 - Company does not have a capacity planning system. Score 3 - Company has a capacity planning system with no MPP integration. Score 5 - Company has a capacity planning system with MPP integration, and cycle time, production rate and stock level calculation.
PPC-04	Departmental PPC	Score 1 - Company does not have PPC for departments. Score 3 - Company has central PPC bases for the departments with periodic communication. Score 5 - Company has PPC bases for the departments linked by a communication channel, within which flows all the necessary information
PPC-05	Integrated schedule system	Score 1 - Company does not have a PPC system to manage pulled flows. Score 3 - Company has two distinct PPC systems to manage pulled and pushed flows. Score 5 - Company has two integrated PPC systems to manage pulled and pushed flows.
PPC-06	Plan and Schedule cycle	Score 1 - Company has a plan and schedule cycle with monthly, or greater, frequency. Score 3 - Company has a plan and schedule cycle with half a month frequency. Score 5 - Company has a plan and schedule cycle with weekly, or lower, frequency.
PPC-07	On time delivery percentage	Score 1 - Company has on-time delivery at lower than 40% of the orders. Score 3 - Company has on-time delivery at between 60% and 80% of the orders. Score 5 - Company has on-time delivery at greater than 90% of the orders.
PPC-08	Value aggregation percentage	Score 1 - Company has production lead time 30 times greater than standard lead time from engineering. Score 3 - Company has production lead time between 10 and 20 times the standard lead time from engineering. Score 5 - Company has production lead time lower than 5 times the standard lead time from engineering.
PPC-09	Inventory turnover	Score 1 - Company has three months, or greater, inventory turnover. Score 3 - Company has a month's inventory turnover. Score 5 - Company has a week's turnover, or lower.
PPC-10	Extra time percentage	Score 1 - Company uses 20%, or greater, of unplanned extra time to meet the delivery dates. Score 3 - Company uses between 10% and 20% of unplanned extra time to meet the delivery dates. Score 5 - Company uses 5%, or lower, of unplanned extra time to meet the delivery dates.



Shop floor indicators		Description of the scores
SHF-01	Volume flexibility	Score 1 - Company does not have varied sizes of equipment and must use larger equipment to produce more than the customer needs. Score 3 - Company has small, medium, and large sizes of equipment, but must use bigger equipment to produce more than the customer needs. Score 5 - Company has small, medium, and large sizes of equipment and use equipment in proportion to customer needs.
SHF-02	Single Minute Exchange of Dies (SMED)	Score 1 - Company does not have a formal process of critical analysis for machine setup. Score 3 - Company has a formal group that eventually makes the critical analysis of the machine setup. Score 5 - Company has a formal group guided by goals of continuous reduction of machine setup times, which results in a critical analysis of setup times.
SHF-03	Focused production	Score 1 - Company has less than 10% of capacity focused on specific family items. Score 3 - Company has between 20% and 30% of capacity focused on specific family items. Score 5 - Company has more than 50% of capacity focused on specific family items.
SHF-04	Total Productive Maintenance	Score 1 - Company only makes corrective maintenance. Score 3 - Company makes preventive maintenance, but lacks a broader maintenance program. Score 5 - Company has a Total Productive Maintenance program and continually trains technicians.
SHF-05	Polyvalence program	Score 1 - Company does not have a formal polyvalence program for technical training of employees. Score 3 - Company has a partial polyvalence program for technical training of employees. Score 5 - Company has a polyvalence program for technical training of all employees.
SHF-06	Standard routine	Score 1 - Company does not use standard routine. Score 3 - Company uses standard routine, balanced with the cycle time, only for the assembly line. Score 5 - Company uses standard routine, with polyvalent employees, balanced with the cycle time for the assembly line and manufacturing cells and keeps standard routine sheets available at the shop floor.
SHF-07	Leveling degree	Score 1 - Company has the leveling factor (average production lot size / average order size) > 2. Score 3 - Company has the leveling factor $1.3 < (\text{average production lot size} / \text{average order size}) > 1.5$. Score 5 - Company has the leveling factor (average production lot size / average order size) < 1.1.
SHF-08	Setup percentage	Score 1 - Company has setup time 30% greater than production time. Score 3 - Company has setup time between 10% and 20% of production time. Score 5 - Company has setup time lower than 5% of production time.
SHF-09	Productive indices	Score 1 - Company has a real productivity lower than planned productivity. Score 3 - Company has a real productivity equal to planned productivity. Score 5 - Company has a real productivity greater than planned productivity.
SHF-10	Non-planned breakdown indices	Score 1 - Company eventually has production downtime because of equipment breakdown. Score 3 - Company rarely has production downtime because of equipment breakdown, but still has emergency maintenance before imminent breakdowns. Score 5 - Company never has production downtime because of equipment breakdown.
SHF-11	Polyvalence indices	Score 1 - Company has less than 20% of polyvalent employees. Score 3 - Company has between 40% and 60% of polyvalent employees. Score 5 - Company has more than 80% of polyvalent employees.

Fonte: Tubino, Poler and Silva (2011, pp. 19-21).



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The authors have stated that there is no conflict of interest.

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