UNIVERSIDADE FEDERAL DE SÃO CARLOS
CENTRO DE CIÊNCIAS EXATAS E DE TECNOLOGIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA DE PRODUÇÃO

NAYARA CARDOSO DE MEDEIROS

EMPLOYEE INVOLVEMENT IN LEAN MANUFACTURING: PRACTICES, RELATIONSHIP AND SCALE DEVELOPMENT

SÃO CARLOS - SP
2023

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Thesis presented to the Postgraduate Program in Production Engineering (PPGEP) at the Federal University of São Carlos, as part of the requirements for obtaining the title of Doctor in Production Engineering

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SÃO CARLOS - SP
2023

UNIVERSIDADE FEDERAL DE SÃO CARLOS

Centro de Ciências Exatas e de Tecnologia
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Folha de Aprovação

Defesa de Tese de Doutorado da candidata Nayara Cardoso de Medeiros, realizada em 24/11/2023.

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O Relatório de Defesa assinado pelos membros da Comissão Julgadora encontra-se arquivado junto ao Programa de Pós-Graduação em Engenharia de Produção.

À Francisco Francielle Pinheiro dos Santos (in memoriam)

Cumpro aqui a promessa que te fiz em não desistir. Obrigada por ser a minha força diária.

AGRADECIMENTO

Agradeço primeiramente à Deus por não desistir de mim e guiar meus passos e decisões com sabedoria.

Fico até sem palavras para agradecer ao meu orientador Moacir Godinho e ao meu co-orientador Gilberto Ganga, que não só me passaram conhecimento como me acolheram durante essa longa jornada. Aprendi com vocês que ser Professor é muito mais que apenas passar conhecimento e agradeço a sorte de tê-los tão humanos quando mais precisei.

Agradeço aos meus pais, Rosana e Ulisses por terem me apoiado incondicionalmente na conquista desse sonho, superando inclusive a distância e a saudade. Essa conquista é para vocês!

Agradeço aos meus pais Dalva e Francisco Paiva por terem me mostrado esse caminho e me mostrado que dá sim pra vencer estudando. Obrigada por nunca permitirem que eu desistisse e por toda paciência até aqui. Aprendi com vocês que o exemplo inspira!

Agradeço à minha avó Onélia por sempre ter uma palavra acolhedora nos momentos de desespero e por me mostrar o amor mais incondicional desse mundo! Te amo vó, agora já pode comemorar.

Agradeço aos meus irmãos Hildebrando, Vitória, Annelise, Ricardo, Maura, Evellyn e Samy pelo apoio, carinho e torcida por mim e pelo meu sucesso.

Agradeço ao meu namorado Diogo Dahlke que com muita paciência e carinho me devolveu a alegria e a vontade de amar. Obrigada por ter estado comigo na reta final dessa conquista! O próximo é você!

Agradeço ao meu tio Paulo (*in memorian)* que tenho certeza que de onde estiver está feliz por mim, pois sempre torceu pelo meu sucesso.

Agradeço à família Medeiros, em nome de meu pai Jamil, que sempre torceram e esperaram por esse momento.

Agradeço ao Jonhatan Magno por toda ajuda, amizade e paciência comigo na tão temida estatística! Obrigada meu amigo!

Agradeço ao Mário por todo suporte e por sempre ter uma palavra amiga para que eu voltasse a confiar no meu trabalho! Muito obrigada!

Agradeço a todos os professores da UFSCar que contribuíram com a minha formação.

Agradeço à minha banca examinadora por toda contribuição ao meu trabalho.

Agradeço aos gestores das empresas que abriram suas portas e possibilitaram um grande conhecimento e a conclusão desse trabalho.

Agradeço à Universidade Federal d Piuí pelo suporte e a todos os colegas professores que sempre estiveram me apoiando e me incentivando. Agradeço também aos meus alunos que comemoram bastante esse momento e que me dão toda força desse mundo pra continuar nessa missão especial!

Agradeço aos amigos que fiz em Teresina, em especial ao João Marcos, Adriana e Tarso que mais que amigos viraram minha família. O famoso “quando eu terminar o doutora gente vai/faz”, acabou.

Agradeço aos amigos que fiz durante esses anos de doutorado, que eu não sei colocar em palavras o quanto são especiais e o quanto os perrengues nos uniram e então VENCEMOS!. Renata, Geandra, Denise, Luciano, Lucas e Bruno vocês tornaram esse desafio mais leve e divertido.

Agradeço aos amigos de Manaus, que mesmo distantes nunca deixaram de mandar um: como você está? Estamos com saudade! Agradeço pelo carinho que nem a distância permitiu acabar: Albano Albuquerque, Kadrine Mendes, Pryscilla Cabral, Kamille Matos, Diego Fernando, Karem Layse e Tairo Freitas, Luciano, Vanessa.

Agradeço à família Pinheiro por todo apoio e por terem me acolhido como família nessa jornada da vida.

A todos que de alguma forma passaram pela minha vida e torceram por mim, meu muito obrigada de coração!

E por fim, eu agradeço ao Francisco Francielle Pinheiro (*in memoriam).* Você que foi meu companheiro, meu noivo, meu amigo, meu maior incentivador! E a ti que como último pedido me fez prometer que me cuidaria e terminaria o doutorado para conseguir realizar meus projetos na nossa UFPI. Consegui. Não desisti! E foi por ti. Olha sempre por mim daí e obrigada pelo privilégio de ter tido você na minha vida.

ABSTRACT

Employee involvement is reported in the literature as a human resource practice that has significantly contributed to the success of lean manufacturing efforts. However, the subject is superficially addressed in the literature, lacking in-depth studies. Thus, the overall objective of this work is to understand the relationship between employee involvement practices in lean manufacturing efforts and to develop a scale capable of measuring these practices' adoption levels. The thesis was structured into three main chapters following an article format to achieve this. The first article used a systematic literature review and expert opinions to identify employee involvement practices in lean manufacturing efforts. Ninety articles were analyzed, resulting in a list of fifteen essential practices. The second article analysed these practices' driving relations and dependence using interpretive structural modeling (ISM) and fuzzy-cross-impact matrix multiplication (Fuzzy MICMAC). As a result, the most influential practices and those with the highest dependence were identified, leading to a framework that shows how companies can prioritize employee involvement practices implementation in lean manufacturing efforts. After identifying the priority, the third article focused on developing a scale to measure the level of practice implementation in companies. The scale construction process started by extracting items from relevant literature. These items underwent expert evaluation and were then subjected to four rounds of Q-sorting to validate them. Once the items were validated, a survey was conducted with manufacturing company operators in the north and southeast regions of Brazil to further validate the scale path for implementation. The result was an instrument that measured employee involvement in lean manufacturing efforts and helped companies to identify opportunities to stimulate employee involvement. A conceptual model was developed to measure employee involvement in lean manufacturing by utilizing best practices. This model can help managers prioritize the implementation of practices that require more attention, leading to better decision-making and increased employee involvement. Consequently, this can lead to more effective and sustainable implementation of lean manufacturing.

Keywords: Employee involvement. Lean manufacturing. Measurement scale. systematic literature review. expert opinion. ISM. Fuzzy MICMAC.

RESUMO

O envolvimento dos funcionários é relatado na literatura como uma prática de recursos humanos que contribuiu significativamente para o sucesso dos esforços de produção enxuta. Contudo, o assunto é abordado de forma superficial na literatura, carecendo de estudos aprofundados. Assim, o objetivo geral deste trabalho é compreender a relação entre as práticas de envolvimento dos funcionários nos esforços de manufatura enxuta e desenvolver uma escala capaz de medir os níveis de adoção dessas práticas. A tese foi estruturada em três capítulos principais seguindo um formato de artigo para conseguir isso. O primeiro artigo utilizou uma revisão sistemática da literatura e opiniões de especialistas para identificar práticas de envolvimento dos funcionários nos esforços de manufatura enxuta. Foram analisados noventa artigos, resultando em uma lista de quinze práticas essenciais. O segundo artigo analisou as relações de condução e dependência dessas práticas usando modelagem estrutural interpretativa (ISM) e multiplicação de matrizes de impacto cruzado fuzzy (Fuzzy MICMAC). Como resultado, foram identificadas as práticas mais influentes e com maior dependência, levando a uma estrutura que mostra como as empresas podem priorizar a implementação de práticas de envolvimento dos funcionários nos esforços de manufatura enxuta. O terceiro artigo focou no desenvolvimento de uma escala para medir o nível de implementação das práticas para o envolvimento dos funcionários no lean manufacturing nas empresas. Depois de identificar a prioridade o processo de construção da escala iniciou-se com a extração de itens da literatura relevante. Esses itens passaram por avaliação de especialistas e, em seguida, foram submetidos a quatro rodadas de Q-sorting para validação. Uma vez validados os itens, foi realizada uma pesquisa com operadores de empresas manufatureiras das regiões norte e sudeste do Brasil para validar ainda mais a escala. O resultado foi um instrumento que mediu o envolvimento dos funcionários nos esforços de produção enxuta. Um modelo conceitual foi desenvolvido para medir o envolvimento dos funcionários na manufatura enxuta, utilizando as melhores práticas. Este modelo pode ajudar os gestores a identificarem práticas que requerem maior atenção. Após priorizar a implementação de práticas que requerem mais atenção, permite-se uma melhor tomada de decisões e a um maior envolvimento dos colaboradores. Consequentemente, isto pode levar a uma implementação mais eficaz e sustentável da produção enxuta.

Palavras-chave: Envolvimento dos funcionários. Manufatura enxuta. Escala de medição. revisão sistemática da literatura. opinião de um 'expert. ISM. MICMAC.

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1 INTRODUCTION

This chapter contextualizes the subject studied, specifying the goals, research questions, and the importance of the study, and describes the research methods used.

1.1 RESEARCH GAP AND QUESTIONS

Lean implementation has been studied for many years. Although it is gaining ground in industries, there is still room to investigate and determine the factors that help and enhance its effectiveness in manufacturing industries, as only a few organizations successfully sustain lean practices. Most lean implementation efforts fail because managers focus on technical mechanisms or tools for implementing sociocultural factors such as effective leadership and employee involvement (STELSON *et al*., 2017).

Recognizing this, Bagal and Dasgupta (2022) conducted a study that identified 17 important factors for success in lean manufacturing efforts and found that employee involvement is one of the most crucial factor Organizations can focus on improving employee involvement to ensure the success of lean manufacturing efforts, and the methods to enhance this practice can provide an additional advantage in achieving the ultimate goal of lean implementation.

According to the human resource management literature, employees are involved when they demonstrate exemplary performance in terms of competence and effectiveness, discretionary effort, creativity and innovative behavior, and they need the skills to do so, must be adequately motivated, and their work environment should offer participation opportunities (APPELBAUM et al., 2001, AHLSTRAND; GAUTIÉ, 2022).

Employee involvement can improve communication among workers and between workers and management, more accessibility to transfer shifts, minor variation in product attributes, less waste, improved quality, lower equipment adjustments, decreased lesions leaves, reduced operating costs, and reduced downtime (GRIGG, 2010). So, it is necessary to stimulate and involve employees to develop opportunities and optimize company processes (VICENTE et al., 2015).

Therefore, employee involvement is one of the practices that greatly contributes to a successful Lean implementation in a company. Several studies analyse the role of employee involvement in lean implementation (e.g., ROSLIN et al., 2019, BERALDIN et al., 2022, QURESHI et al., 2022). However, there is a lack of research that analyses in-depth the practices that drive employee involvement in a lean context.

The development of such a measurement scale is essential to evaluate progress in employee involvement and to assist researchers, consultants, and managers in making more informed decisions about their lean manufacturing implementation (MENOR; ROTH (2007).

Studies on scaling employee engagement were found, but with a focus on evaluating organizational-level stress management interventions (RANDALL; NIELSEN; TVEDT, 2009), employer engagement measurement tool developed for use in the human resource and management (SHUCK; ADELSON; REIO (2017), mediation of employee engagement and moderation of mental involvement (ABABNEH, 2022). Studies related to measuring worker involvement in lean manufacturing were found, however, employee involvement is a secondary practice in these studies that primarily aim to measure lean manufacturing (HERZOG; TONCHIA, 2014, GODINHO FILHO; GANGA; GUNASEKARA, 2016). Hence, existing scales fail to measure the specific thoughts, ideas and feelings related to employee involvement in lean manufacturing, making it essential to develop a specific measuring instrument for this purpose.

Although Rachman and Ratnayake (2019) and Neirotti (2020) highlight specific employee involvement practices, no comprehensive, structured study exists. Roslin et al. (2019) noted that these practices that contribute to this involvement do not receive due attention, resulting in an impact unknown in the literature and by companies embarking on lean implementation.

Given this gap, the first two research questions of the present thesis arise.

Q1: What are the employee involvement practices in the lean manufacturing context?

Q2: What is the role, that is, how they relate, of each practice identified in the employee involvement efforts in lean implementation?

The main result is a list of 15 practices for employee involvement in lean manufacturing: aligning employee's goals with the company's goals, continuous development of employee's leadership skills, creating improvement teams for group decision-making, develop multifunctional workers, drive suggestion programs, education programs, training, and personal development, encouraging innovation and technologies, intensive use of communication and feedback mechanism, making job resources available, management support, promoting employee-friendly policies, promoting empowerment and autonomy to employees, providing career advancement opportunities to employees, use of kaizen events and use of reward-based incentives. These practices were classified into motivational, human resource management (HRM), and operational practices, for didactic reasons. Among these groups, the practices most referenced in the literature are those linked to motivational elements, namely group decision-making; education, training, and personal development programs; promoting empowerment and autonomy to employees; and management support.

Having identified in the literature the main employee involvement practices in lean manufacturing and after realizing that most of the identified practices were related to HRM practices, we realized that there was still a need to explore the topic more deeply, since according to Koemtzi et al. (2023), several studies report the role of HRM in the success of lean implementation, but superficially approaching the topic as part of the discussion of other issues. Thus, research on the subject is still theoretical and does not discuss the relationship between such practices.

Therefore, to study this relationship, a foundation was sought in the theory of Organizational Change Management since this theory establishes a structure to manage the human aspects of change management, such as the implementation of new practices to increase the probability of success (BANERJEE et al., 2019; MORAN; BRIGHTMAN, 2000) supporting and emphasizing the importance of considering the interdependencies between different practices and how they can interact and impact employee involvement in lean manufacturing efforts. Following such rationale, two new research questions arose:

Q3: What is the relationship between the employee involvement practices?
Q4: What path should companies follow to involve employees in LM efforts?

Finally, when analysing the results of the ISM and the fuzzy MICMAC with support from the literature, the RQ4 objective was met with the proposal of a framework. This framework expands knowledge about OCM theory by guiding companies towards a path to change that must occur in organizations implementing employee involvement practices in a Lean Manufacturing environment.

During the proposition of the framework, we noticed that it would be difficult for companies to measure their efforts toward implementing the practices for employee involvement. Although we clearly defined each practice and gave companies a path to follow when implementing them, it would be hard for these companies to identify where they are on such a path. For this, Wright et al. (2017) suggest that measurement tools help managers decide which practices need investment and attention, providing more significant possibilities to increase this involvement (WRIGHT et al., 2017). Corroborating this, Van Assen (2021) points out that instruments are not developed exclusively to measure engagement in the literature and that few studies present instruments to measure isolated practices that influence this process.

The development of scale is a fundamental and everyday activity in operations management. According to Menor and Roth (2007), a good measurement is a prerequisite for good empirical science. It assists researchers, consultants, and managers evaluate their progress in employee involvement in lean manufacturing implementation. Thus, we proposed a fifth research question in our thesis:

Q5: How to measure employee involvement in lean implementation?

The practices identified by the systematic literature review were used to measure employee involvement in lean. This allowed building a list with items to develop a measuring instrument. The next step was refinement of items with experts and then the purification stages of these items, with academic experts and company managers to be pre-tested, thus evaluating their reliability and validity. Then, a large sample was used to validate and develop the measurement scale, making it possible to measure the involvement so that companies perceive opportunities to stimulate this involvement of their employees and thus make more proactive decisions regarding the actions to be developed, facilitating the successful implementation and sustainability of lean.

1.2 OBJECTIVES

The general objective of the present thesis was to **develop a scale capable of measuring the level of adoption of employee involvement practices in lean manufacturing efforts.**

Specific goals were established to achieve the present thesis's general objective:

- (SO 1) identify the employee involvement practices and the role of each of the practices identified.

- (SO2) analyse the contextual relationship and dependency amongst practices for increasing employee involvement and propose path companies should follow to involve employees in LM efforts.

- (SO3) develop and validate a measurement scale reflecting employee involvement in lean.

Table 1.1 shows the research questions and methods related to the proposed specific objectives.

Table 1.1 - Specific objectives of the research

Research questions	Specific objectives	Research method	Thesis chapter
Q1: What are the employee involvement practices in the lean manufacturing context? Q2: What is the role, that is, how they relate, of each practice identified in the employee involvement efforts in lean implementation?	**SO 1**	Theoretical background Systematic Literature Review and Expert Opinion	2.Thoretical background 3. Employee involvement practices in lean manufacturing: a multi-method approach
Q3: What is the relationship between the essential employee involvement practices? Q4: What path should companies follow to involve employees in LM efforts?	**SO2**	Systematic literature review, Expert opinion, ISM, and Fuzzy MICMAC analysis	4. From getting support to implement formal practices: a framework to involve employees in lean efforts
Q5: How to measure employee involvement in lean implementation?	**SO 3**	Scale development (survey)	5. Employee involvement in lean manufacturing measurement scale

Source: elaborated by the author.

1.3 OVERVIEW OF THE RESEARCH METHODS USED IN THIS THESIS

The present thesis involved a combination of 5 research methods: a systematic literature review, expert opinion, ISM, Fuzzy MICMAC, and survey.

First, a systematic literature review (chapter 3) was conducted to identify employee involvement practices and the role of each of these practices in lean manufacturing efforts.

A systematic literature review is essential to accurately and reliably summarize evidence on a topic (MOHER et al., 2009). The systematic method used in this research followed Thomé et al. (2009), who suggested developing it in four stages: (1) Planning and formulation of the problem; (2) identification and filtering of studies; (3) data analysis and data synthesis and (4) results reporting.

In the first stage, the research question was defined. In the second stage, search strings are defined, databases are selected, inclusion and exclusion criteria are specified, and studies are identified and filtered. The third step covered the process of data analysis and data synthesis, and 90 articles were analysed to extract lean's leading employee involvement practices. Finally, the research findings were reported in the fourth step by presenting theoretical and practical findings.

Then, seven specialists were consulted to validate the practices found in the literature. For this, a questionnaire was sent asking them to answer three main questions about these practices: (1) Is the practice related to employee involvement in lean manufacturing? (2) Is the practice's description similar to another practice? (3) Is the practice's title adequate? (4) Is the practice's description adequate?

The interpretive structural modelling (ISM) technique (chapter 4) was used to develop a hierarchical structural model to analyse the contextual relationship and dependency amongst practices for employee involvement in lean manufacturing implementation. For the ISM approach, a structural self-integration matrix was created with the help of experts' suggestions and opinions.

After finding the hierarchical model from the ISM, we developed a cluster diagram using the Fuzzy cross-impact matrix (Fuzzy MICMAC). This approach was used to complement the ISM method (BIANCO et al., 2021) since the fuzzy MICMAC allows an understanding of the intensity of the relationship between these practices (MOTA et al., 2021).

Therefore, the ISM and Fuzzy cross-impact matrix (Fuzzy MICMAC) was used to develop a hierarchical structural model that demonstrates the relationships between the 15 employee involvement practices in lean manufacturing efforts found in the systematic literature review.

Finally (chapter 4), the method used to construct and validate the scale measurement of employee involvement in lean was based on the research of Menor and Roth (2007). Thus, four steps were used: (i) Specifying the construct domains and generate items; (ii) Establishing the Constructs' and Items' Reliability and Validity –

Sorting Item; (iii) Ensuring Convergent and Discriminant Validity (Pre-test); (iv) Ensuring Convergent and Discriminant Validity (large survey).

1.4 THESIS STRUCTURE

This thesis is structured in 6 chapters, summarized in Figure 1.1. Chapter 1 introduces and contextualizes the subject studied and its motivation and specifies its specific objectives and importance. A brief description of the research method used is also provided.

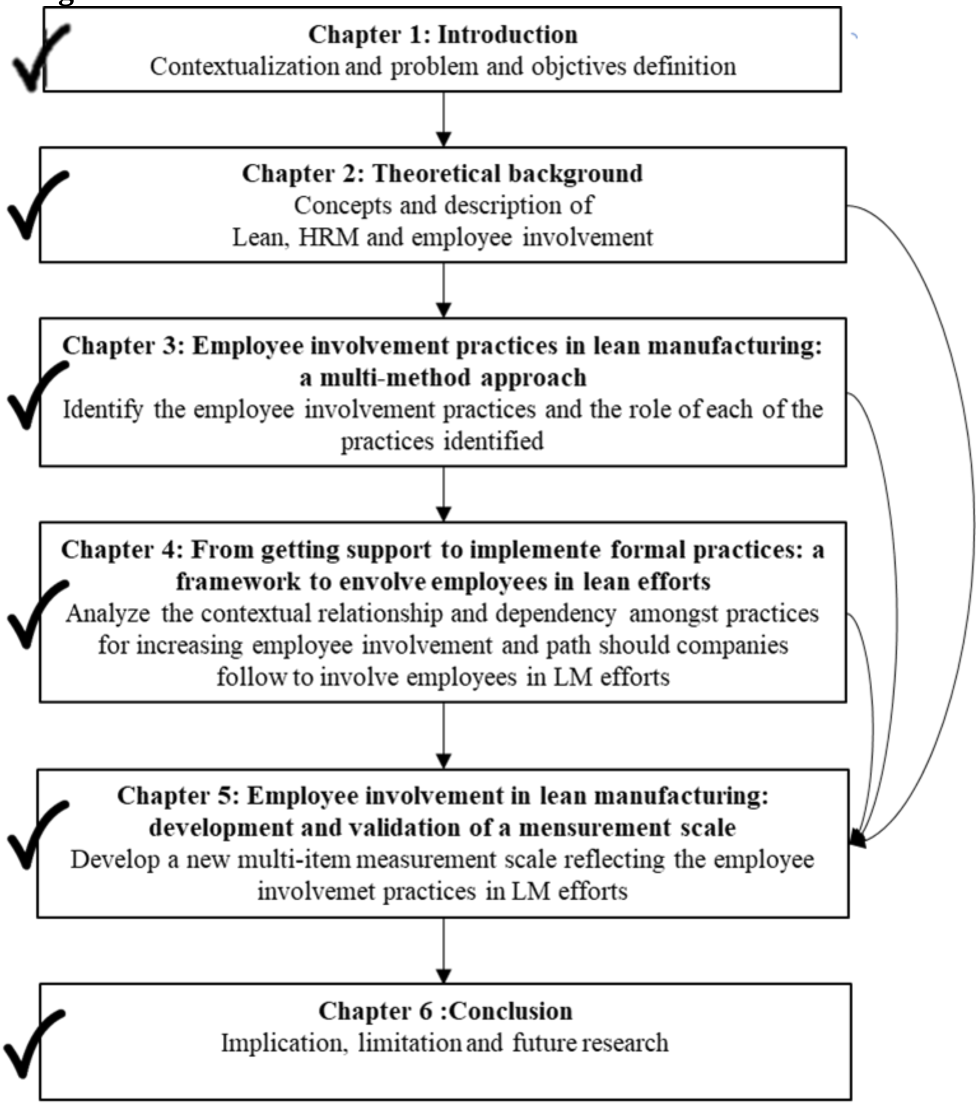
Chapter 2 is a brief conceptual presentation on lean manufacturing, human resource management, and employee involvement in lean.

Chapter 3 presents a systematic literature review on the motivating practices for employee involvement in lean manufacturing. The systematic literature review was carried out to map the knowledge on the subject in the literature and understand which practices are essential to motivate employees in lean. In addition, the review makes it possible to guide future research in the area.

Chapter 4 presents the contextual relationship and dependency amongst practices for increasing employee involvement and also proposes a path companies should follow to involve employees in LM efforts.

In Chapter 5, a measurement scale is developed and validated to reflect employee involvement in lean manufacturing. Finally, Chapter 6 presents the conclusion of this research.

Figure 1.1 - Thesis structure



Source: Elaborated by the author

2 CONCEPTUAL BASIS

To contextualize the topics of this research, this section presents a brief theoretical background on lean manufacturing, human resources management and employee involvement.

2.1 LEAN MANUFACTURING

According to Gollan et al. (2014) and Kumar et al. (2022), the social aspect of work only began to be taken seriously in the 1970s and 1980s, with the rise of Japan as a competitor manufacturing to the United States of America (USA). This happened because Western companies were experiencing difficulties due to the consequences of the end of the Second World War and, therefore, began to reexamine their internal operations to find alternative ways to compete with the USA.

Then, the solution found came through a set of practices called *lean manufacturing practices* in the 40s (GOLLAN et al., 2014). The term "*lean manufacturing*" was coined by researchers from the Massachusetts Institute of Technology International Motor Vehicle Program. However, the true origin of *lean* is the Toyota Production System (TPS), led by Japanese engineers Taiichi Ohno and Shigeo Shingo in Japan. It consists of two main components: a *Just-in-time* (JIT) production system and a system of respect for human beings, focusing on the active participation of employees and the elimination of activities wasted by workers (HERNANDEZ-MATIAS et al., 2019).

Lean involves principles that help to understand better its fundamentals and prospects (WOMACK; JONES, 2003) and guide the company towards its performance objectives. According to Womack and Jones (2003), some of the main principles are:

a) **Specify value**: precisely determine the value *per* specific product.

b) **Identify the flow value:** map the value chain for each product.

c) **Ensure the flow:** make value flow without interruptions.

d) **Work with heavy production:** let the customer pull product value.

e) **Seek perfection:** the principle of continuous improvement.

Saurin and Ferreira (2008) explained that *lean* practices enable the implementation of its principles. Thus, principles are the basis of *lean* production and practice s are used to achieve them. The practices carried out in any company that wishes to implement them in their production process may be different or implemented in different ways. However, its base, represented by the principles, needs to be well defined, then the changes will be minor (SAURIN; FERREIRA, 2008).

Thus, *lean* is often conceptualized as a set of practices designed to eliminate waste. However, some authors have pointed to the importance of the human factor for the success of this implementation and conceptualized it as a program directed by employees designed for socio-technical integration (technical and human) to find and eliminate waste, as tacit knowledge is performed only by the shop floor worker and cannot be obtained without the employee's willingness, thus making it essential for workers to be actively involved in the successful identification and elimination of waste (LANDER; LIKER, 2007, SHAH; WARD, 2007, PAKDIL; LEONARD, 2016, WICKRAMASINGHE, 2015, ANGELIS; FERNANDES, 2017, KUMAR et al., 2022).

The success of Lean adoption hinges on crucial factors, particularly the commitment and support of management. Effective leadership plays a pivotal role in providing strategic direction by clearly communicating Lean Management (LM) goals, generating employee interest in the philosophy, and overseeing the project. Leaders must demonstrate respect for employees and recognize their efforts in process improvement. Management's responsibility extends to offering financial support during LM adoption and empowering employees through continuous training (MAWARE; PARSLEI II, 2022).

Achieving and maintaining a Lean enterprise necessitates a significant shift in leadership and employee behavior, culture, and attitudes. This behavioral change can be challenging to complete, leading organizations to enlist external Lean coaches/trainers to impart these changes through training. Cultural and attitudinal shifts require everyone in the organization to step out of their comfort zones and alter their interpersonal dynamics. Individuals must also adapt how they carry out specific tasks. Thus, cultural changes rely on top management's accountability and example leadership (MAWARE; PARSLEI II, 2022).

A company seeks to undergo a cultural transformation by adopting a significant number of Soft-Lean practices (related to human aspects). Although the implementation of various Hard-Lean practices is considered successful in Lean Management (LM), the results reveal that 75% of LM change efforts ultimately fail, facing challenges in integration within production organizations. Recent research indicates that the primary causes of this failure are linked to human factors, such as inadequate training, lack of commitment from top management, and poor communication (SUBRAMANIAN; SURESH; WILLIAM, 2023).

Despite the importance of human-related elements in Lean results, there is a shortage of studies addressing the connection between human-related practices and LM, crucial for successful implementation. There is an urgent need for research exploring a broad range of Human-Related Lean Practices (HRLP) to optimize operational performance (SUBRAMANIAN; SURESH; WILLIAM, 2023).

2.1.1 *Lean* technical practices (LTP's)

Synonymous with good manufacturing practices, *lean* manufacturing practices provide organizations with a decisive competitive advantage (GOLLAN et al., 2014). Rigid or techniques are tools, methodologies, procedures, and methods used to improve a company's manufacturing process and reduce waste (GARCÍA-ALCARAZ et al., 2019).

Lean production has been identified in the literature as a set of associated practices such as *just-in-time*, continuous improvement, Kanban system, total productive maintenance (TPM), 5S, total quality management (TQM), etc., for implementation in companies (GODINHO FILHO; GANGA; GUNASEKARAN, 2016). The concepts of *lean* manufacturing technical practices are presented in Table 2.1.

Table 2.1 - Concepts of lean manufacturing technical practices

Practices	Concept	Reference
Multifunctional teams	Multifunctional teams consist of a worker using a system called task rotation. The worker performs several tasks on the assembly line, thus learning to be efficient in each charge he serves.	Monden (2015)
Quality management in the process	Quality management eliminates or simplifies the processes that do not add value to the product. Many tasks in companies are poorly dimensioned and can often be definitively eliminated by rearranging the process's execution mechanism, the larger one they belong to.	Oliveira (2004)
Visual Management	Visual management consists of visual information about problems in the production system.	Monden (2015)
Just in time (JIT)	Provide necessary items in the required amount and in the correct location to eliminate inventories and losses and ensure continuous production flow.	Shingo (1996); Ohno (1997)

Practices	Concept	Reference
Kanban	*Kanban* is a way to achieve just in time through cards containing information collection, transfer, and production sent from one process to its predecessor.	Ohno (1997)
Manufacturing Cells	Manufacturing cells are layout provisions of a production system where the machines are grouped to reduce the movement of employees, decrease the transportation of materials, decrease the stock of materials, and maintain a closer relationship with employees improving the workplace.	Monden (2015)
Total productive maintenance	TPM's goal is to engage a sense of unity and responsibility among supervisors, operators, and maintenance technicians and aims to increase the efficiency of the plant and equipment. It uses autonomous maintenance to develop inspection, lubrication, and cleaning routines.	Tondato (2004)
Value stream mapping	The Value Stream is any action that adds value or is not required to bring a product for all critical flows to its transformation. Mapping the Value Stream is to walk the path of the entire process of material transformation and product information.	Luz and Buiar (2004)
Continuous improvement (*kaizen*)	Continuous improvement has the philosophy of not accepting the status quo of an organization and constantly making changes to increase its competitiveness. Continuous improvement should focus on the internal progress of the skills and abilities of people. These activities make the workplace dynamic, and changes often occur.	Tondato (2004)
Production leveling (*Heijunka)*	Leveling production in volume and combination (mix), that is, takes the total volume of orders in a period and levels them so that the same quantity and combination are produced each day.	Liker (2005)
Standardized operations	Standardized operations seek to reduce the inefficiencies of the process, minimizing the number of employees and unnecessary stocks. Employees work in a standard way, with pre-established movements to avoid wasting.	Monden (2015)
Quick tool change	A tool aims to improve the setup time by simplifying and improving the setup activities for less than ten minutes.	Shingo (2000)

Source: Adapted from Medeiros et al. (2016).

Tortorella and Fogliatto (2014) warned that the technical factors of *lean* change tend to be more emphasized, while the organizational learning process and human resource management tend to be neglected.

2.1.2 Soft Practices – Human resource management practices

Soft-lean are aimed at the involvement and commitment of management and employees, with activities such as training, learning, and teamwork (GARCÍA-ALCARAZ et al., 2019).

The Toyota Production System (TPS) is a system known to be the "creation of people, not cars," and *lean* will be successful and completed if managers know their employees and teams (not just the processes and tools) and promote an environment healthy with a consistent organizational culture. Consequently, TPS presupposes the development and training of people to contribute enormously to the organization's growth since people must feel the need to identify and solve problems through the scientific method (VICENTE et al., 2015).

Elizondo, Grabot and Ngouna (2016) emphasized the imbalance between people and technical practices, adding that there is a lot of confusion in the literature on how to connect employee contributions and recognize him as a critical facilitator on the *lean* implementation process and that there is not enough research examining human resource management associated with the implementation phase.

Recently, in addition to agreeing that most research so far focused on the technical aspects of *lean* (i.e., implementation of practices and their effect on performance), rather than issues related to "people," Negrão et al. (2017), Vivares-Vergara et al. (2016) and Onofrei et al. (2019) complemented that they changed their focus on "why" *lean* works (or not) and started to address human resource management (HRM) practices.

Thus, recent studies (SUBRAMANIAN; SURESH; WILLIAN, 2023, MAWARE; PARSLEY II, 2022) have revealed that the leading causes for the failure to implement *lean* were related to human factors, such as lack of management commitment worker involvement, and poor communication or inadequate training. Although researchers have recognized they importance of such factors in the companies´results; there is a need for more studies that explore the inter-correlation between *lean* practices related to man (HERNANDEZ-MATIAS et al., 2019).

Thus, the elimination of waste is associated with cost reduction and improves the conditions and safety of staff. Therefore, according to TPS, employees must be considered an active part in improving the company's processes and products. Continuous improvement belongs not to the board of directors but all company associates (VICENTE et al., 2015).

Implementing lean policies and practices involves organizational changes and the active participation of employees. The transformation of the company necessitates the incorporation of employees' discretionary effort. This process is reliant on comprehensive human resources management, and successful lean plants tend to utilize soft Lean Management (LM) practices more extensively than their unsuccessful counterparts (BOURANTA; ANTONY, 2022).

Bouranta e Antony (2022) identified eleven main themes in the field of Lean-HR, namely Training, Leadership, Culture, Participation, HR department role, Commitment, Job Design, Teamwork, Communication, Impact on employee, and Resistance to change. Yadav et al. (2019) complement with the factor financial capability.

Among the human resource practices cited in the literature, the involvement of employees has received attention from researchers because it is argued that the human factor is one of the main barriers to achieving the successful implementation of practices, whereas if workers do not want to engage or refuse to accept the performance, the probability of implementation and maintenance failure is relatively high (RANE; SUMMAPWAR; RANE, 2016).

2.2 EMPLOYEE INVOLVEMENT IN LEAN

Traditionally, organizations aimed for faster and cheaper production, but the contemporary globalized and competitive landscape requires a reevaluation of strategies. In this context, human capabilities are recognized as crucial assets, leading to a shift in organizational focus from purely productive and technological factors to valuing human factors. Modern organizations strategically leverage human and intellectual capital. Engaged and motivated employees enhance their commitment, resulting in increased satisfaction and improved customer relationships (MEIRINHAS et al., 2022).

An involved employee typically demonstrates high involvement and enthusiasm for their work and organization. They are passionate about their job, more motivated, and willing to make a greater contribution to help the organization. Employee engagement is a concept that describes the employee's effort to act in line with the organization's interests (SARAGIH, et al. 2021). Engagement is also defined as a form of emotional and logical motivation where individuals focus strongly on their work, leading to the achievement of final objectives (MCSHANE; GLINOW, 2017).

The positive influence of employee involvement on the success of lean has been debated in the literature for a long time, for example, in the work of Mc LAchlin (1997), who identified that employee involvement plays a central role in its implementation, proven in works more recent ones such as Ahmad, Schrocder and Sinha (2003) who state that companies that involve their employees in decisions consequently increase the effectiveness of lean practices and Godinho Filho, Ganga and Gunasekaran (2016) who suggested that the greater the involvement of workers, the thinner it is: the company, and the lighter it, the higher its operational performance.

The last decade has seen more studies exploring human factors' practical and theoretical aspects and implementing employee involvement in lean environments (HERNANDEZ-MATIAS et al., 2019).

Realizing the growing emphasis of academia on human resource management, especially on understanding the processes of employee involvement in lean implementation in companies, there is a need for a complete and broad understanding of the topic for a successful implementation of lean (ROSLIM et al., 2019).

Wickramasinghe (2015) conceptualized work involvement as an individual's level of psychological identification with the specific work in which they are involved or absorbed. The author added that lean implementation requires a team-oriented work environment where employees are willing, able, and empowered to participate in decision-making. To optimize operational performance related to lean, it is essential to understand the work of operator-level employees.

Evans and Redfern (2010) explained that employee involvement is associated with the growing recognition of the link between people and company performance and the requirement to understand and manage the talent premiums imposed on organizations by the continuous change in the business environment.

Furthermore, Gupta, Holladay, and Mahoney (2000) pointed out that employee involvement brings pride to employees and provides a sense of job security. Companies obtain better results with better attitudes and initiatives. Employees can generate new ideas and improve their problem-solving skills, and the level of responsibility of all workers increases.

However, although employees and management want the company to succeed, it is necessary to understand that people with different roles can have different origins and, therefore, different world views (LODGOARD, 2016).

From this, it is clear that employees are insecure about making improvements, as this could cause the need for fewer workers and increase the possibility of dismissals, thus creating the need to generate mutual trust between employees and employers, developing conditions that ensure that the workforce would not be reduced by causing employees to accept greater responsibilities (SHOOK, 2010).

Furthermore, Dellve et al. (2018) warn about management's difficulty in taking risks and being genuinely willing to involve its employees and give significant confidence, which can cause a lack of desire on the part of top management to reduce the hierarchical structure and give up control and power.

Wilkinson, Dundon, and Grugulis (2007) warned that employee errors should not be attributed solely to factory floor operators. It also requires management to increase employee understanding and commitment, ensuring more significant organizational contributions.

Wickramasinghe (2015) added that employees' beliefs and attitudes about various dimensions of lean manufacturing still do not receive due attention. It is necessary to balance the needs of the organization and the psychosocial needs of employees.

Thus, meeting the needs of employees becomes an essential factor for implementing lean practices since capable, flexible, committed, and creative human resources are needed they improve and explore the capture of knowledge, leading to a competitive advantage (PAKDIL; LEONARD, 2016).

However, it is essential to emphasize that the first and most important decision to implement an employee involvement program is to do it for the right reasons (GRIG, 2009). Implementing an employee involvement program in the face of challenges posed by managing culture and processes requires a deep and long-term commitment to the effort, including changing the fundamental characteristics of the organization's operations. Furthermore, Grigg (2010) stated that an employee engagement program is a never-ending commitment.

It will decline if the organization stops thinking and working on its involvement program. Thus, Bellisario and Pavlov (2018) confirm this growing concern among companies with practices encouraging employee involvement.

2.3 ORGANNIZATIONAL CHANGE MANAGEMENT

Mathur, Kapoor, and Swami (2023) define organizational change management as a process in which transformation or alteration occurs within an organization, either through cultural shifts or through organizational restructuring, to meet current demands. To overcome challenges, employees need to realign and redesign all business processes.

Inadequate modeling of change can lead to paralysis due to confusion and uncertainty, impacting organizational stability.

In an increasingly complex and dynamic business environment, organizations continually strive to adapt their operations to evolving circumstances (ERRIDA; LOFTI, 2021). This effort requires significant investments to implement various changes and adapt to the changing context. However, change management is a complex and risky process, often resulting in difficulties and failures to achieve expected results (ERRIDA; LOFTI, 2021).

Studies indicate that the majority of organizational change initiatives fail, with an estimated failure rate of 60-70%. This high failure rate raises ongoing concern and interest in factors that can reduce failure and enhance the success of organizational change (ERRIDA; LOFTI, 2021).

It has been proposed that successful change endures when individuals promote changes in their behaviors while remaining within the organization, as change implementation occurs through individual efforts within the organization (MATHUR; KAPOOR; SWAMI, 2023). Literature suggests that studies on organizational change have primarily focused on organizational factors, neglecting issues-oriented toward the individual. Understanding theories and models of change management begins with comprehending change at the individual level (MATHUR; KAPOOR; SWAMI, 2023).

The success rate of Lean Management transformations is notably low in non-Japanese companies, achieving only a 10% successful implementation, with reported benefits often dissipating over time (SARTAL; VÁZQUEZ; LOZANO-LOZANO, 2022).

Literature highlights the lack of connection between Lean tools and Lean culture as a common root problem in Lean transformations (SARTAL; VÁZQUEZ; LOZANO-LOZANO, 2022). Lean implementation is often poorly received by employees and middle management, attributed to top management's inability to build a persuasive narrative for Lean implementation, characterizing it as a strategic change requiring a shift in management and employee perceptions of Lean (MALIK; ABDALLAH, 2020).

Industrial management literature, particularly in the context of changing behaviours and attitudes, has overlooked the allowance for strategic changes in how organizations operate. However, this aspect is central in organizational studies literature. Therefore, understanding how Lean practices can be implemented as part of an organizational change process is crucial (MALIK; ABDALLAH, 2020).

3 EMPLOYEE INVOLVEMENT PRACTICES IN LEAN MANUFACTURING: A MULTI-METHOD APPROACH

This section presents evolved employee involvement essential search and the critical practices to boost employee involvement.

3.1 INTRODUCTION

Lean manufacturing is an employee-oriented program designed in an integrated sociotechnical system to find and eliminate waste (ALEFARI ET AL., 2020; PAKDIL; LEONARD, 2017; VILKAS et al., 2021; WALTHOFF-BORM; CHALMET, 2014). However, despite the importance of lean practices in enhancing organizational efficiency (ARGIYANTARI et al., 2022; NAWANIR et al., 2021; PARK, 2022), the implementation of lean manufacturing systems involves several difficulties and is easier to implement in some companies than in others (DELLVE et al., 2018; LOPES et al., 2023; VON HAARTMAN et al., 2021). This can be attributed to the fact that besides implementing tools and techniques, their success requires changes in the duties of managers and supervisors, and a high influence of cultural values (BRKIC; TOMIC, 2016; RANE et al., 2016).

In this regard, soft-lean practices aspects, mainly those related to human resource management (HRM) need to be considered in lean implementation (HERNANDEZ-MATIAS et al., 2020; KERAMIDA et al., 2022). Employee involvement has gotten much attention in the literature about human resource practices. This occurs because the human factor is regarded as a primary barrier to the successful implementation of practices, since the likelihood of implementation and maintenance failure is relatively high if employees refuse to participate in or accept implementation (BERALDIN et al., 2022; RANE et al., 2016; ROSLIN et al., 2019). Wickramasinghe (2016) conceptualized an individual's involvement in lean context as their psychological identification with the specific job they are involved in or absorbed by.

The active involvement of employees in lean appears in various ways, such as task adaptation, work team variations in the production flow, position exchanges within the working group, and commitment of each employee to continuous improvement (WICKRAMASINGHE; WICKRAMASINGHE, 2016). Kusrini et al. (2019), and Roslin et al. (2019) warned that the primary objectives of employee involvement include increasing employee understanding and commitment, thereby ensuring an improved contribution to the organization. Besides, Rachman and Ratnayake (2019) point out that several practices have the potential to drive greater involvement of employees, for example, develop multifunctional workers (NARAYANAN et al., 2022; SIGNORETTI; SACCHETTI, 2020), Management support (MATHIYAZHAGAN et al., 2022; QURESHI et al., 2022), among other practices.

Several studies analyze the role of employee involvement in lean implementation (e.g. ROSLIN et al. (2019); BERALDIN et al. (2022); QURESHI et al. (2022)). However, there is a lack of research that analysis in-depth the practices that drive employee involvement in a lean context. Although Rachman and Ratnayake (2019) and Neirotti (2020) highlight specific employee involvement practices, no comprehensive and structured literature study is on the topic. In this way, to the best of our knowledge, our study was the first to comprehensively analyse the lean literature to identify employee involvement practices. In addition, we use a multi-method approach, encompassing a systematic literature review (SLR) to identify practices and expert consultation to validate and refine those practices. To fill this theoretical gap, the research questions (RQs) of this study are:

- RQ1: What are the employee involvement practices in the lean manufacturing context?
- RQ2: What is the role of each of the practices identified in the employee involvement efforts in lean implementation?

By answering these two research questions, this paper aims to contribute to the literature and practice in two ways. First, we identify and validate a list of employee involvement practices in the lean manufacturing context. This list of practices provides insight for consultants and managers to understand which practices have the potential to drive employee involvement in lean implementation. Second, we discuss how practices can drive employee involvement efforts. For example, the lack of employee involvement is considered one of the reasons why companies fail to achieve the expected impact of implementing lean systems (ROSLIN et al., 2019). In this context, employees' complete involvement in lean implementation and maintenance is crucial, and the implementation process cannot grow without a workforce working together.

The structure of this paper is as follows: In Section 3.2, the multi-method approach used is described. In Section 3.3, a list of employee involvement practices is presented and discussed, and theoretical and practical implications are provided. Lastly, in Section 3.4 our conclusions, limitations, and recommendations for future studies are presented.

3.2 RESEARCH METHOD

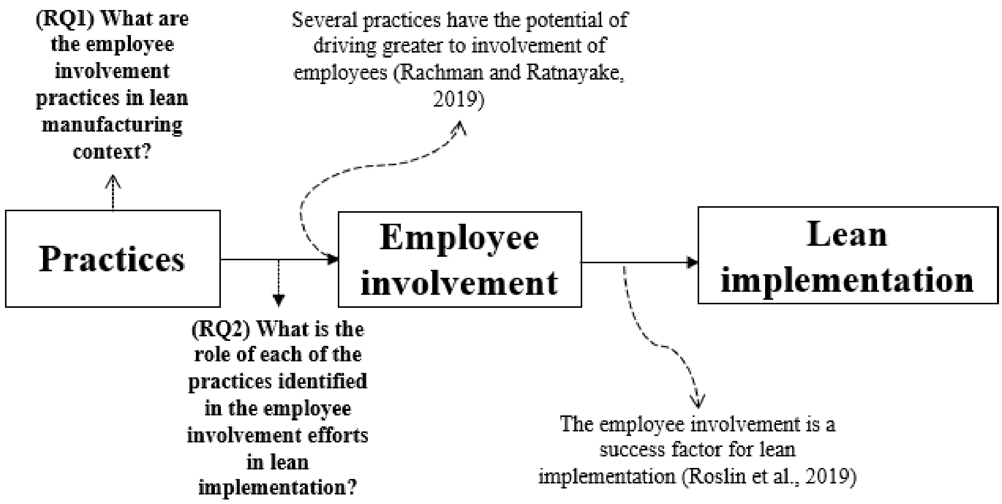
The design of this research covered a mixed-method approach. This research approach is characterized by presenting different methods of the same nature (Bryman, 2012). In this regard, two methodological phases were considered: (1) identification of the preliminary list of employee involvement practices in lean manufacturing through an SLR; (2) refinement and validation of the list of practices with experts.

3.2.1 Phase 1: identification of the preliminary list of practices

The SLR was conducted to enable the identification of a preliminary list of capabilities. This study considered the eight steps proposed by Thomé et al. (2016). These steps cover four main steps: (1) planning and formulation of the problem; (2) identification and filtering of studies; (3) data analysis and data synthesis; and (4) results reporting.

The first step covered the definition of the two RQs presented in Section 1. Therefore, identifying the research gap was initially necessary, enabling the purpose of the analytical framework shown in Figure 3.1. This framework directs the research's efforts to understand the employee involvement practices (RQ1) and the role of these practices in the employee involvement efforts in lean implementation (RQ2). Furthermore, the structure of the frameworks proposed by Bueno et al. (2020) and Bueno et al. (2022) was considered during the construction process of this framework, which, despite being focused on smart production planning and control context, can be replicated in other areas of study.

Figure 3. 1 Analytical framework



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Source: Elaborated by the author

The second stage, which included the definition of search strings, selection of databases, specification of inclusion and exclusion criteria, and identification and filtering of studies was performed after the RQs had been established. Thus, the search terms were initially identified. Thomé et al. (2016) note that search strings must encompass the entirety of the literature on the subject being examined without being overly broad, which would result in a pointless research effort. To ensure a proper analysis of the literature, the keywords were carefully chosen based on an initial analysis of relevant lean articles. Two main keywords constructs, "lean manufacturing" and "employee involvement", were identified (Table 3.1). These keywords were selected to ensure a broad and thorough examination of the literature.

Table 3.1 - Search string

Lean Manufacturing construct		Employee involvement construct
“lean” OR “Toyota” OR “just-in-time”	AND	“employee involvement” OR “employee participation” OR “employee engagement” OR “employee commitment” OR “human resource management”

Source: Elaborated by the author

As a primary criterion for selection, databases were chosen based on their alignment with the study area (DURACH et al., 2017) once the search strings had been defined. Due to their widespread use in SLRs in the field of operations management (e.g. BUENO et al. (2020); BAGNI et al. (2021); GÓMEZ PAREDES et al. (2022)), Web of Science, Scopus, and Engineering Village databases were selected. The final sample of articles was then limited to those that had been published in academic journals, had full English texts available, and included at least one employee practical involvement, as per the inclusion and exclusion criteria as shown in Table 3.2.

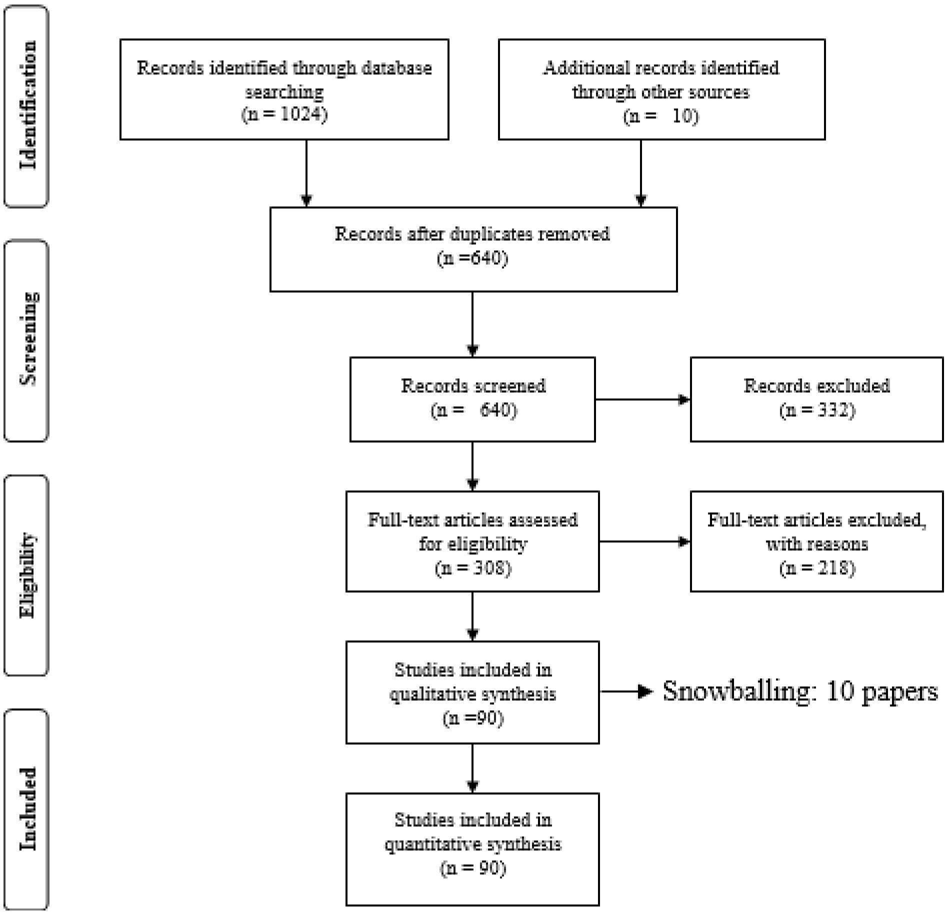
Table 3.2 - Details of inclusion and exclusion criteria.

Criteria type	**Criteria**	**Detail**
Exclusion	Full text in English	The paper has only the title and abstract in English.
	Academic Journal	The paper does not come from an academic journal.
	No full text	The paper does not available complete for reading.
	Non-related	The paper does not address any practical employee involvement.
Inclusion	Closely related	The paper addresses one or more driving employee involvement practices.

Source: Elaborated by the author

In order to complete the second stage, studies were identified and filtered following the recommendations made by Moher et al. (2009) in their Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) model. The PRISMA flowchart is shown in Figure 3.2, verifying that the analysis process started with identifying 640 non-repeated articles. This number was reduced to 308 after reviewing the titles and abstracts. A full-text review was conducted, resulting in the selection of 90 articles for the final analysis sample. To ensure a thorough analysis of the literature, a snowball approach was used, driven by the guidelines proposed by Gaikwad et al. (2021). Of the 90 articles in the final sample, 10 were identified using this snowball approach. This result demonstrates that the snowball approach was used to select more than 10% of the total articles, as these articles, while presenting employee involvement practices, did not have it as their primary focus research.

Figure 3. 2 PRISMA flowchart



Source: Elaborated by the author

The third step covered the process of data analysis and data synthesis. The final sample of 90 articles was analyzed, and the data was encoded using the NVivo Software. In addition, a simple matrix containing the name of the practice, its description, and its source was created. Following the conclusion of all content analyses for all articles, several meetings were held to refine the collected data. As a result, a preliminary list of 15 practices was identified in the literature. Finally, in the fourth stage, the research findings were reported, primarily through the presentation of theoretical and practical findings.

3.2.2 Phase 2: refinement and validation of the list of practices with experts

Following the guidelines proposed by Cardoso et al. (2012) and Callefi et al. (2022), lean manufacturing experts refined and validated the preliminary list of practices. Initially, a sample of seven experts was chosen, each with at least five years of academic or practical experience in lean manufacturing. The sample size is considered valid since it is higher than in previous studies such as Mathiyazhagan et al. (2013) (2 experts), Govindan et al. (2015) (5 experts), and Callefi et al. (2022) (6 experts).

A questionnaire that included a matrix with the title and description of the practices was sent to the experts. This questionnaire also instructed the experts to analyze each of the 15 practices using the following criteria: (1) Is the practice related to employee involvement in lean manufacturing? (2) Is the practice's description similar to another practice? (3) Is the practice's title adequate? (4) Is the practice's description adequate? As a result of the analysis of the questionnaire responses, a final list of 15 practices was identified and only names and concepts were readjusted.

3.3 RESULTS AND DISCUSSION

Based on the multi-method approach, a final list of 15 employee involvement activities was selected and validated, as shown in Table 3.3. These practices include the different aspects that need to be considered to help employees get involved in actions linked to the implementation of lean manufacturing.

Table 3.3 - Key employee involvement practices in lean manufacturing practices obtained from literature and refined by experts

Practices	Definition	Reference
Aligning employee's goals with company's goals	The company and employees goals must be strategically aligned when their behaviors correspond to their utilizations strategy (Gagnon et al., 2008).	Brown and Reich (1989); Power and Sohal (1997); Baird and Lansbury (1998); Gagnon et al. (2008).
Continuous development of employee's leadership skills	The company should develop leadership skills (communication, listening, and feedback). This is important because a higher degree of trust in leadership results in proactive behaviours by frontline employees, encouraging them to use autonomy in their day-to-day tasks to identify and make systematic improvements in work processes (Anand et al., 2012).	Cheng (1991); Cheng and Musaphir (1993); McBain (2007); Evans and Redfern (2010); Anand et al. (2012); Godinho Filho et al. (2016); Lodgaard et al. (2016); Dellve et al. (2018); Soetara et al. (2018); Sisson (2019); Ahlstrand and Gautié (2022); Azalanzazllay et al. (2022).
Creating improvement teams for group decision-making	Employee involvement implies that employees work in a group wherein each member has some level of input in the decisions of the group, thereby allowing them to be taken in a more systematic, integrated, and analytical manner (Grigg, 2010).	Brown and Reich (1989); Golhar and Stamm (1991); Cheng (1991); Berg and Smith (1993); Cheng and Musaphir (1993); Karlsson and Åhlström (1996); McLachlin (1997); Power and Sohal (1997); Baird and Lansbury (1998); Clifford and Sohal (1998); Gupta et al. (2000); Power and Sohal (2000); Godard (2001); Richbell (2001); Birdi

Practices	Definition	Reference
		et al. (2008); Grigg (2010); Angelis and Fernandes (2012); Gollan et al. (2014); Stadnick and Antosz (2015); Rothstein (2016); Godinho Filho et al. (2016); De Vries and Van der Poll (2018); Roslin et al. (2019); Chen et al. (2020); Neirotti (2020); Signoretti (2020); Beraldin et al. (2022); Narayanan et al. (2022).
Develop multifunctional workers	Cross-training ensures that the experitise of employees is not limited to a single activity (Cheng, 1991).	Golhar and Stamm (1991); Cheng (1991); Cheng and Musaphir (1993); Berg and Smith (1993); Gupta et al. (2000); Power and Sohal (2000); Angelis and Fernandes (2012); Stadnick and Antosz (2015); Rothstein (2016); Soetara et al. (2018); Hernandez-Matias et al. (2020); Signoretti and Sacchetti (2020); Narayanan et al. (2022).
Drive suggestion programs	These programs create an environment conducive to employee involvement by encouraging reward-based improvement suggestions (Roslin et al., 2019).	Cheng (1991); Kim and Bae (2005); Angelis and Fernandes (2012); Jürgens and Krzywdzinski (2013); Liker and Ballé (2013); Gollan et al. (2014); Marksberry et al. (2014); Stadnick and Antosz (2015); Godinho Filho et al. (2016); Rothstein (2016); Roslin et al. (2019); Chopra and Fernando (2020); Kumar and Mathiyazhagan (2020); Neirotti (2020); Beraldin et al. (2022).
Education programs, training, and personal development	Companies should provide employees with programs that promote knowledge and self-development. These programs can be internal, performed by consultancies, or continuous training with external or postgraduate studies sponsored by the company (McLean et al., 2017; Stadnicka and Antosz, 2015).	Puvanasvaran et al. (2009); Assarlind (2015); Marin-Garcia and Bonavia (2015); Rothstein (2016); Stadnicka and Antosz (2015); Brkic and Tomic (2016); Shokri et al. (2016); Berlec et al. (2017); McLean et al. (2017); Boxall and Winterton (2018); Moica et al. (2019); Pereira et al. (2018); Rachman and Ratnayake (2019); Roslin et al. (2019); Sisson (2019); Chen et al. (2020); Hernandez-Matias et al. (2020); Jing et al. (2020); Kumar and Mathiyazhagan (2020); Signoretti (2020); Tran et al. (2020); Benkarim and Imbeau (2021); Van Assen (2021); Ahlstrand and Gautié (2022); Azalanzazllay et al. (2022); Boxall and Huo (2022); Qureshi et al. (2022).
Encouraging innovation and technologies	This refers to using information technology systems and active methodologies as a source of knowledge to inspire involvement of employees with lean changes (Moica et al., 2019).	Stadnick and Antosz (2015); Berlec et al. (2017); Boxall and Winterton (2018); Pereira et al. (2018); Moica et al. (2019); Pereira and Liker (2021).
Intensive use of communication	Companies should use informal conversations and meetings to involve	Cheng (1991); Evans and Redfern (2010); Assarlind (2015); Vicente et al.

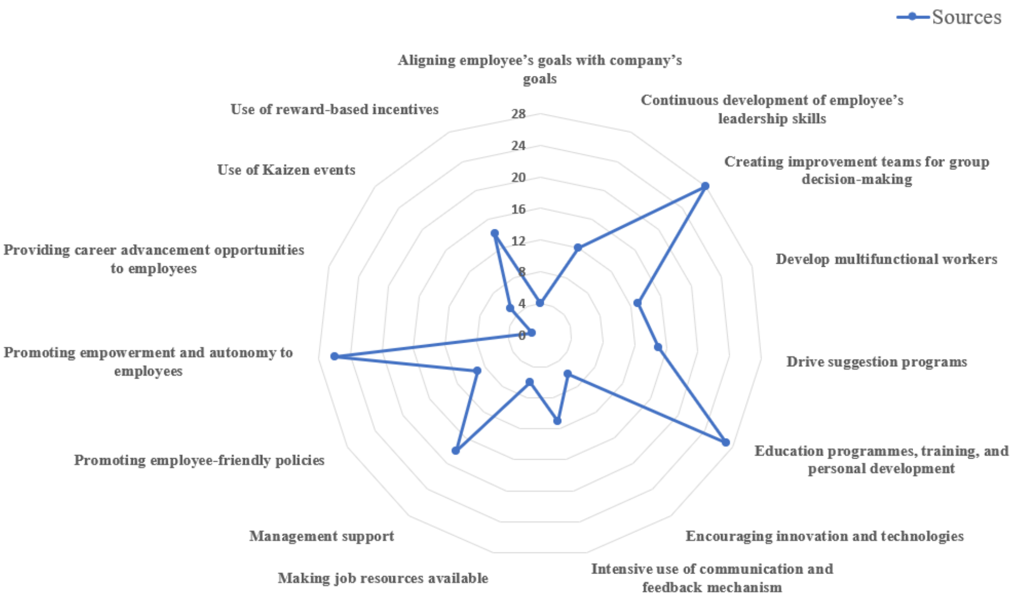
Practices	Definition	Reference
and feedback mechanism	employees. Day-to-day operations can be improved through informal discussions and meetings (Vicente et al., 2015).	(2015); Roslin et al. (2019); Hernandez-Matias et al. (2020); Neirotti (2020); Signoretti (2020); Tran et al. (2020); Ahlstrand and Gautié (2022); Klein et al. (Klein et al., 2022).
Making job resources available	The company should make all the resources required to perform a task available. Resources refer to ‘physical, psychological, social, or utilisation aspects of the job (Huo and Boxall, 2018).	Clifford and Sohal (1998); Grigg (2010); McLean et al. (2017); Stelson et al. (2017); Huo and Boxall (2018); Dellve et al. (2018).
Management support	Management should support workers in performing improvement tasks (Bergquist and Westerberg, 2014).	McLachlin (1997); Daily and Huang (2001); Bergquist and Westerberg (2014); Bhattacharya (2015); Vicente et al. (2015); Soetara et al. (2018); Roslin et al. (2019); Dellve et al. (2018); Rachman and Ratnayake (2019); Hernandez-Matias et al. (2020); Signoretti (2020); Tran et al. (2020); González-Boubeta et al. (2021); Tezel et al. (2021); Boxall and Huo (2022); Klein et al. (Klein et al., 2022); Mathiyazhagan et al. (2022); Qureshi et al. (2022).
Promoting employee-friendly policies	The company should Promoting employee-friendly policies such as an enabling environment created for employees who want to participate and are highly involved in lean-centered activities through interpersonal relationships, improved quality of life at work, and balance between work personal life (Roslin et al., 2019).	Godard (2001); Ahmad et al. (2003); Boxall and Winterton (2018); Beraldin et al. (2019); Roslin et al. (2019); Malik and Abdallah (2020); Yuik et al. (2020); Benkarim and Imbeau (2021); Boxall and Huo (2022).
Promoting empowerment and autonomy to employees	Companies should empower employees to perform and operate correctly, because liberty allows them to use their creative decision-making and managing objectives to improve processes (Roslin et al., 2019).	Brown and Reich (1989); Cheng (1991); Berg and Smith (1993); McLachlin (1997); Power and Sohal (1997); Clifford and Sohal (1998); Power and Sohal (2000); Godard (2001); Daily and Huang (2001); Birdi et al. (2008); Evans and Redfern (2010); Richardson et al. (2010); Wickramasinghe and Wickramasinghe (2011); Anand et al. (2012); Angelis and Fernandes (2012); Bergquist and Westerberg (2014); Marin-Garcia and Bonavia (2015); Stadnick and Antosz (2015); Boxall and Winterton (2018); Roslin et al. (2019); Van Assen and De Mast (2019); Rupasinghe and Wijethilake (2020); Signoretti and Sacchetti (2020); Ahlstrand and Gautié (2022); De Koeijer et al. (De Koeijer et al., 2022); Narayanan et al. (2022).

Practices	Definition	Reference
Providing career advancement opportunities to employees	Provide career opportunities to employees towards their future growth in the utilization based on their merits and performances (Bhattacharya, 2015).	Bhattacharya (2015).
Use of Kaizen events	Kaizen events are used to solve problems regularly and increase workers' participation towards making improvements. Impressed by the outcome, the employees strive to keep the event alive through the daily Kaizen methodology. Corporate culture thrives, resulting in higher employee participation (Vo et al., 2019).	Wickramasinghe and Wickramasinghe (2017); Rachman and Ratnayake (2019); Vo et al. (2019); Kumar and Mathiyazhagan (2020); Wickramasinghe and Chathurani (2020).
Use of reward-based incentives	Programs implemented to reward workers, in addition to fixed remuneration (salary and annual raises), with variable pay that depends on performance, increasing collective efforts, professionalism, and flexibility (Wickramasinghe and Wickramasinghe, 2016). Employee involvement can be improved by recognising achievements and rewarding innovation (Soetara et al., 2018).	Evans and Redfern (2010); Ganster et al. (2011); Haleem et al. (2012); Gollan et al. (2014); Martinez-Jurado et al. (2014); Assarlind (2015); Marin-Garcia and Bonavia (2015); Stadnick and Antosz (2015); Brkic and Tomic (2016); Rothstein (2016); Wickramasinghe and Wickramasinghe (2016); McLean et al. (2017); Boxall and Winterton (2018); Soetara et al. (2018).

Source: Elaborated by the author

From the data presented in Table 3.3, a radar chart was constructed that indicates the number of articles that cited each of the practices (Figure 3.3). The practices that were most highlighted in the analyzed literature were Creating improvement teams for group decision-making (28), Education programs, training, and personal development (27), Promoting empowerment and autonomy to employees (26); and Management support (18). Although this information does not suggest that these activities are the most crucial for driving employee involvement, it is possible to verify that such practices are more addressed in the literature.

Figure 3. 3 Number of sources by employee involvement practice



Source: Elaborated by the author

Another significant feature to mention about the final list of recognized practices is that there is an alignment of certain practices regarding particular topics. Therefore, to improve the discussion about the practices, they were classified into three fundamental groups: (i) motivational practices; (ii) human resource management practices, (iii) operational practices.

3.3.1 Motivational practices

Five practices are associated with motivational factors: Aligning employee's goals with company's goals; Creating improvement teams for group decision-making; Education programs, training, and personal development; Promoting empowerment and autonomy to employees; and Management support. Motivational practices encourage employees to participate in lean initiatives (BERGQUIST; WESTERBERG, 2014; NEIROTTI, 2020). Furthermore, as shown in Figure 3, four of these five practices are the most frequently cited in the analyzed literature. As a result, it appears that motivational practices have received more attention in the present literature.

"Aligning employee's goals with company's goals" is the first practice in this group. For the success of lean initiatives, it is vital that organizations have well-defined objectives and manage to involve their employees in such objectives (GAGNON et al., 2008). This advantage of ensuring that the aims of the company and the employees are aligned is to promote a potential reduction in tensions in the work environment (BAIRD; LANSBURY, 1998).

According to Neirotti (2020), the additional effort created by the implementation of lean manufacturing can be reduced by establishing decision-making teams. Furthermore, the author emphasizes that these group decisions allow employees to experience improved levels of personal efficacy, better performance in quality work, and overall satisfaction with working conditions.

"Creating improvement teams for group decision-making" is the second practice in this group. According to Neirotti (2020), the additional effort created by the implementation of lean manufacturing can be reduced by establishing decision-making teams. Furthermore, the author emphasizes that these group decisions allow employees to experience improved levels of personal efficacy, better performance in quality work, and overall satisfaction with working conditions.

“Education programs, training, and personal development” is the third practice in this group. Employee involvement in lean manufacturing is closely related to their knowledge of themes related to continuous improvement (BERGQUIST; WESTERBERG, 2014). Therefore, for employees to involve in lean efforts, they must be trained and qualified in these concepts.

“Promoting empowerment and autonomy to employees” is the fourth practice in this group. Employee empowerment and autonomy are significant factors for your involvement in lean efforts. Neirotti (2020) points out that empowerment and autonomy enable employees to work more efficiently, which is critical for lean manufacturing implementation.

“Management support” is the fifth practice in this group. Bergquist and Westerberg (2014) underline the necessity of management support in supporting employee involvement in these lean initiatives. In this regard, a solid commitment from management is required for lean implementation success since, without such support, employees are unlikely to become involved (BENKARIM; IMBEAU, 2021).

3.3.2 Human resource management (HRM) practices

Seven practices are associated with Human resource management (HRM) factors: Continuous development of employee's leadership skills; Encouraging innovation and technologies; Intensive use of communication and feedback mechanism; Making job resources available; Promoting employee-friendly policies; Providing career advancement opportunities to employees; and Use of reward-based incentives. These practices encompass factors connected to the availability of human resources for lean efforts, which is regarded as one of the critical resources for organizational performance (WICKRAMASINGHE; WICKRAMASINGHE, 2020). This coincides with Benkarim and Imbeau (2021), who claim lean depends on human resources, as 67-99% of the lean work encompasses human involvement.

"Continuous development of employee's leadership skills" is the first practice in this group. Sisson (2019) argues that one of the critical reasons for the failure of lean adoption is that due to the focus typically being primarily on technical tools, issues such as leadership are left aside. The author also points out that an ineffective development of employee's leadership skills might severely diminish employee involvement in lean efforts. Some of the primary leadership abilities that may be consistently enhanced are communication, listening skills, feedback, performance management, and recognition (DELLVE et al., 2018; EVANS; REDFERN, 2010).

"Encouraging innovation and technologies" is the second practice in this group. One of the advances in the lean literature of the last decade is the understanding of the possibility of using and encouraging innovation and technologies to motivate workers' involvement. Stadnicka and Antosz (2015) and Moica et al (2019) note the usage of Information Technology (IT) systems and digital technology as a source of knowledge and communication that can encourage employees to produce new improvements with innovative ideas.

"Intensive use of communication and feedback mechanism" is the third practice in this group. Benkarim and Imbeau (2021) affirm it is vital to inform the employees about the “why” and educate them about the “how” of Lean adoption. Employee challenges to lean implementation are generally related to insufficient communication and inadequate flow of information between management and employees (TRAN et al., 2020). Therefore, it is vital to pay attention so that the failure in the implementation of lean occurs if the process and the expected results are not adequately transferred to all the functional areas of the firm (ANGELIS; FERNANDES, 2012; NEIROTTI, 2020).

"Making job resources available " is the fourth practice in this group. Fixed and variable compensation employed as incentive-based compensation depends on the availability of resources provided to the lean implementation project. However, this availability of resources is not only financial but also of time and materials associated with the continuous improvement process (BENKARIM; IMBEAU, 2021; BOXALL; WINTERTON, 2018). In addition, this availability of resources makes it possible for employees to be more involved in lean-related activities.

"Promoting employee-friendly policies" is the fifth practice in this group. Ahmad et al. (2003) consider that promoting employee-friendly policies is essential for obtaining and reinforcing the necessary behavior of employees to get involved in lean efforts. In addition, there is a need to create an employee policy that creates specific conditions and a favourable work environment for employees involved in lean implementation (BENKARIM; IMBEAU, 2021; ROSLIN et al., 2019).

"Providing career advancement opportunities to employees" is the sixth practice in this group. Bhattacharya (2015) underlines the necessity of the organization delivering career possibilities to employees for their future progress based on their merits so that they feel comfortable in their position. The literature shows that many employees perceive that Lean is accompanied by job losses, and greater work, among other negative aspects (BENKARIM; IMBEAU, 2021). Therefore, one of the strategies to encourage involvement in lean initiatives is to offer employees a career development plan (BOXALL; HUO, 2022).

"Use of reward-based incentives" is the seventh practice in this group. A well-known form of recognition is the use of reward-based incentives in addition to the employee's fixed compensation. The literature indicates that this variable remuneration should be based on the group's effort through incentives to achieve goals or for implemented suggestions for improvement (MARIN-GARCIA; BONAVIA, 2015).

3.3.3 Operational practices

Three practices are associated with operational factors: Develop multifunctional workers, Drive suggestion programs, and Use of Kaizen events. Operational practices are the practices of lean process improvement tools. That is, they are practices oriented toward the technical aspect of lean implementation (NARAYANAN et al., 2022). Therefore, in addition to practices related to motivation and resources, operational practices also contribute to increasing the level of involvement of employees in lean efforts.

"Develop multifunctional workers" is the first practice in this group. Developing multifunctional workers promotes rotation among different occupations and enables employees to vary their working activities and enhance their skills. In addition, occupational diseases generated from repeated and straining actions are avoided (SIGNORETTI; SACCHETTI, 2020), and there are stimulants for knowledge development (NARAYANAN et al., 2022).

"Drive suggestion programs" is the second practice in this group. Creating channels that allow employees to express their ideas, report problems, or suggest changes, is a key part of involving employees in lean initiatives (CHENG, 1991; GODINHO FILHO et al., 2016; ROSLIN et al., 2019; STADNICKA; ANTOSZ, 2015). Thus, with the suggestion programs, it is possible to take advantage of the fact that workers are generally in an ideal position to suggest strategies for resolving problems (CHENG, 1991; MARIN-GARCIA; BONAVIA, 2015).

"Use of Kaizen events" is the third practice in this group. Vo et al. (2019) emphasize that conducting Kaizen events helps maintain direct communication with managers and provide feedback, thereby inducing closeness and enabling friendly policies for employees' involvement. Furthermore, these events can make skeptical workers enthused when they realize the lean benefits (KUMAR; MATHIYAZHAGAN, 2020).

3.3.4 Theoretical and practical contributions

The importance of employee involvement for the successful implementation of lean manufacturing principles has been widely discussed in the scholarly literature. However, despite the extensive research in this area, it has been noted that there is a notable lack of studies that conduct an in-depth examination of the practices used to involve employees in lean manufacturing.

These findings contribute both theoretically and practically. In the theoretical context, there are two main contributions. The first contribution covers identifying and validating a list of 15 practices that drive employee involvement. The second contribution is the discussion of practices, highlighting how such practices are related to employee involvement. In addition, this discussion covered the categorization of practices into three main groups: motivation practices, HRM practices, and operational practices.

In a practical context, this list of practices can be used to guide managers to create programs for greater employee involvement in lean-to build a more collaborative environment. The list can also support the construction of tools to assess the involvement of employees in lean initiatives.

3.4 CONCLUSION

The general objective of this research was to identify and discuss the main practices contributing to employee involvement in lean manufacturing. Even though several authors discuss certain employee involvement practices, the novelty of this study is the use of a multi-method approach to identify and validate these practices.

In this regard, a list of 15 practices was identified based on an SLR of practices and subsequently validated with experts. These practices can be organized into three main groups, covering aspects of motivation, HRM and operation. In addition, it was identified that in the analyzed literature the four most cited practices in the studied literature are related to aspects of motivation: Creating improvement teams for group decision-making (28), Education programs, training, and personal development (27), Promoting empowerment and autonomy to employees (26); and Management support (18).

This study has a limitation: the papers were collected from only three databases using the strings mentioned in the materials and methods section. We aimed to minimize these constraints by selecting the most extensive databases regarding content (AGHAEI CHADEGANI et al., 2013) and performing a strategic crossover of the selected keywords.

Finally, based on the results, future research can be carried out to empirically evaluate the effect of each of these practices on employee engagement in lean implementation. Methods such as multiple study cases and surveys can be used to support this empirical analysis.

4 FROM GETTING SUPPORT TO IMPLEMENT FORMAL PRACTICES: A FRAMEWORK TO INVOLVE EMPLOYEES IN LM EFFORTS

In this chapter, the map of the relationship between the practices for employee involvement in lean manufacturing is developed. For this, the preliminary list of practices identified in the Systematic Literature Review was validated in consultation with experts. The Interpretive Structural Modelling (ISM) method was used to develop a hierarchical model. Fuzzy MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) analyzed such practices' dependence and driving power.

4.1 INTRODUCTION

Lean manufacturing (LM) emerged from the successful experience of the Toyota Motor Company in achieving high levels of operational efficiency by eliminating waste in the production system (JAMES; JONES, 2014). In this regard, LM has contributed to improved firm performance (LOPES *et al.*, 2023).

The implementation procedure must be appropriate, given the significance of LM. However, many lean implementation efforts fail because managers focus on technical practices (e.g., quick-change tool, leveling, and Kanban), neglecting human resource practices to implement sociocultural factors such as effective leadership and employee involvement (SIGNORETTI; SACCHETTI, 2020). In this regard, the effective implementation of LM depends not only on hard-lean practices but also on soft-lean practices, namely human-related practices (HERNANDEZ-MATIAS *et al.,* 2020). One of the essential aspects associated with this soft context is human resource management (HRM), which for different authors is considered one of the critical factors for lean implementation (ALEFARI *et al.*, 2017; NEGRÃO *et al.*, 2020).

Prasad et al. (2020) argue that the fundamental aspects of HRM in the context of lean implementation are those related to ensuring that workers are involved, motivated, qualified, capable of multitasking, and understand customer value. Among these listed factors, employee involvement is critical to promoting an adequate HRM (NEIROTTI, 2020). This importance is based on the assumption that employee involvement promotes tacit knowledge derived from their daily activity at workstations (DOMBROWSKI, MIELKE, AND SCHULZE, 2012). In addition, Qureshi et al. (2022) identified that LM depends on employee involvement.

According to Koemtzi et al. (2023), several studies report the role of HRM in the success of lean implementation, but there still needs to be more research that addresses employee involvement. In addition, previous studies only address employee involvement aspects as part of the discussion of other topics, such as the relationship between lean and well-being (BERALDIN *et al.*, 2019), the human dimension of lean (MAGNANI *et al.*, 2019), the moderating role of Industry 4.0 in lean (TORTORELLA, GIGLIO, *et al.*, 2019). Qureshi et al. (2022) address employee involvement in LM, the discussion needs to be done more in-depth since the research focuses on 15 critical success factors. In addition, Although Medeiros et al. (2023) address a list of Employee involvement practices in LM, the research has only a theoretical nature and does not discuss the relationship between such practices. Thus, the aspects related to employee involvement in LM are covered extensively. However, to the best of our knowledge, our study is the first to investigate the path for involving employees in LM efforts from the perspective of Organizational Change Management (OCM) theory. To fill this theoretical gap, the research questions (RQs) of this study are:

- RQ1: What are the practices that help to involve employees in LM efforts?
- RQ2: What is the relationship between the essential employee involvement practices?
- RQ3: What path should companies follow to involve employees in LM efforts?

This paper aims to contribute to the literature and practice in four ways by answering these three questions. First, we identify the employee involvement practices in LM. Second, we explore the dependency relationship among employee involvement practices in LM. This result offers scholarly empirical insight into the already discussed but less frequently tested relationship between employee involvement practices in LM. Third, a Fuzzy MICMAC analysis was performed, which resulted in a matrix which provides insights for top management to understand the relative importance and interdependence among practices for employee involvement in LM. Finally, we propose a framework with a path to involve employees in lean manufacturing efforts.

The foundation of our research is the OCM theory. This theory establishes a structure for managing the human aspects of change management, such as implementing new practices to increase the likelihood of success (BANERJEE *et al.*, 2019; MORAN;

BRIGHTMAN, 2000). In this regard, our analysis considers that the OCM theory supports and emphasizes the importance of considering the interdependencies between different practices and how they can interact and impact the involvement of employees in lean manufacturing efforts. Several models (e.g. Lewin's change model (LEWIN, 1947), Bridges' change model (BRIDGES, 1991), Kotter's change model (KOTTER, 1995)) are included in OCM theory. These models provide steps to guide actions related to change management (SHANG *et al.*, 2021).

The remainder of the paper is organized as follows: A review of concepts related to OCM theory is presented in Section 4.2. The research method employed in this research is shown in Section 4.3. This methodology is applied in Section 4.4 to demonstrate the interrelationships among influencing practices and to classify those practices (Section 5). Finally, Section 4.6 draws the study's overall conclusions and theoretical and managerial contributions.

4.2 ORGANIZATIONAL CHANGE MANAGEMENT (OCM) THEORY

Because today's business environment is so dynamic, it is critical to consider the aspects inherent in the change management literature (MITRA *et al.*, 2019). OCM is defined as a process in which actions are carried out to ensure the continuous renewal of various organizational aspects (e.g. capabilities, direction, structure) to deal with changes related to internal (e.g. employees) and external (e.g. customers) stakeholder demands of the organization (MORAN; BRIGHTMAN, 2000).

In response to the need for businesses to adapt to this ever-changing environment, several OCM models have emerged over the last few decades (SHANG *et al.*, 2021). Table 1 summarizes the main OCM models described in the literature. Lewin's change model (LEWIN, 1947) is regarded as one of the most important models in the literature on change management (SHANG *et al.*, 2021). This model presents three basic steps that need to be considered for an organization to adopt a new habit or norm. Other significant models emerged in the 1990s, such as Bridges' change model (BRIDGES, 1991) and Kotter's change model (KOTTER, 1995). Bridges' change model is based on transition theory, with three stages of change, resistance to change in the first stage, little perception of the need for change in the second stage, and finally, the benefits of change are understood in the third stage (BRIDGES, 1991). Kotter's change model consists of eight steps covering fundamental concepts that will guide organizational change.

Table 4.1 - Summary of organization change management (OCM) models

Model	Steps	Application context	Source
Lewin’s change model	3	General	Lewin (1947)
Bridges' change model	3	General	Bridges (1991)
Kotter's change model	8	General	Kotter (1995)
GE’s change acceleration process model	7	General	Garvin (2000)
Mento's change model	12	General	Mento et al. (2002)

Source: Elaborated by the author

Two other critical models for the change management context emerged in the 2000s: GE’s change acceleration process model (GARVIN, 2000) and Mento's change model (MENTO *et al.*, 2002). Based on Lewin's (1947) model, GE’s model has seven stages that guide the leader throughout the entire change process (MENTO *et al.*, 2002). Finally, Mento's change model was inspired by several existing models to propose a 12-step approach to change management.

While Lewin's change model presents three steps, having a more straightforward structure, Mento's change model establishes a more complete structure, expanding the steps and discussions covered in previous models (MENTO *et al.*, 2002). Even in the face of this increased complexity of change management models, a common characteristic of the models presented (Table 1) is that they all focus on the general application rather than a specific problem, such as lean manufacturing implementation. Being more specific when studying organizational change management theory can help to develop a deeper understanding of how to effectively implement change initiatives within specific sectors or using specific management approaches. For example, several authors have proposed frameworks or models for topic-oriented change management. Mitra et al. (2019) presented a framework concentrating on the reality of a corporation in the insurance sector, while Banerjee et al. (2019) proposed a framework connected to promoting positive change in teaching in an educational institution.

4.2.1 The role of Organizational Change Management (OCM) theory in Lean Manufacturing (LM)

A limited number of studies examine the role of OCM theory in the context of LM, according to a literature review and further supported by Almanei et al. (2018). Sahoo (2022) explains the need to examine the LM from the perspective of OCM theory, emphasizing that applying the LM itself can be regarded as a change management process.

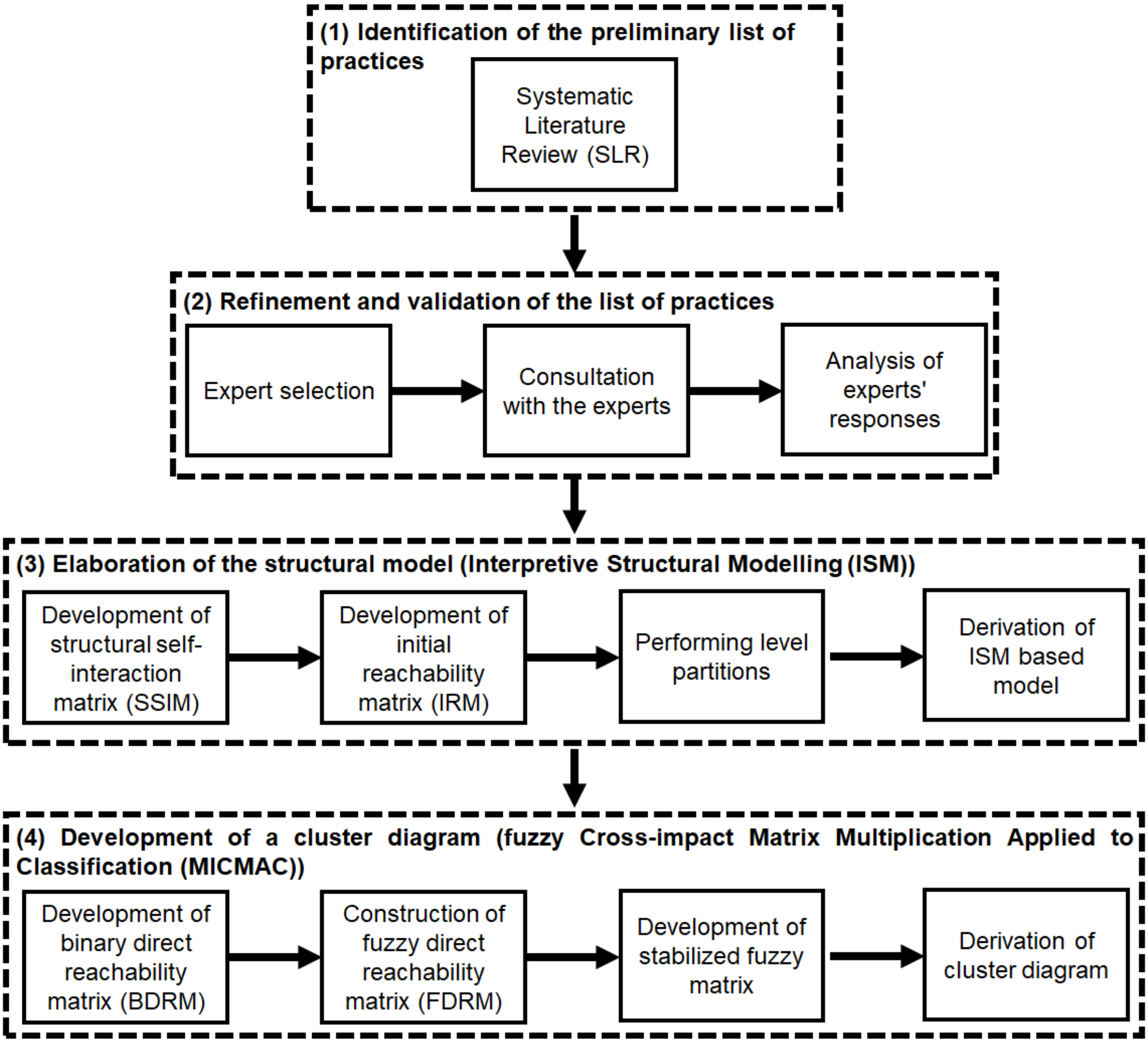
Lastra et al. (2019), Almanei et al. (2018), and Nordin et al. (2012) proposed a framework to support LM implementation based on OCM theory. While the other frameworks do not specifically address employee involvement issues, Almanei et al. (2018) proposed a framework based on Kotter's change model, which consists of eight steps. The authors noted that employee involvement emerges as a crucial factor in creating a climate for change, being one of the base factors to support the actions for implementing and sustaining the proposed changes (LM iniciative).

Set against this background, it is critical to comprehend a path for ensuring employee involvement in the process of establishing and maintaining the LM. To the best of our knowledge, no studies have been conducted that address a framework with a roadmap to guide employee involvement in LM activities. Furthermore, the proposed framework was developed on the premise that involving employees is also a change management process that follows a certain path, including practices followed at each step.

4.3 RESEARCH METHOD

The design of this research comprises a mixed-method approach. This type of research approach is characterized by providing a combination of qualitative and quantitative methods (Bryman, 2012). Accordingly, this research covers four methodological phases (Figure 4.1): (1) identification of the preliminary list of practices for employee involvement in LM through a systematic literature review (SLR); (2) refinement and validation of the list of practices with specialists; (3) elaboration of the structural model; and (4) development of a cluster diagram showed the elements driver and dependence power.

Figure 4.1 - Research method



Source: Elaborated by the author

4.3.1 Phase 1: identification of the preliminary list of practices

The preliminary list of practices for employee involvement in LM was derived from an SLR (MEDEIROS et al., 2023). The developed SLR was based on the guidelines proposed by Denyer and Tranfield (2009). In the first step, it was identified that the research focus is on identifying papers dealing with aspects related to employees involvement in LM. In the second step, considering Engineering Village, Web of Science, and Scopus databases, the search was performed using a combination of keywords related to employee involvement and LM, including the following:

- Employee involvement: (1) “employee involvement”; (2) “employee participation”; (3) “employee engagement”; (4) “employee commitment”; (5) “human resource management”;
- LM: (1) “lean”; (2) “Toyota”; (3) “just-in-time”.

In the third step, as search filtering, only articles published in journals and English were considered, leading to 640 non-repeated articles being identified. Subsequently, the title and abstracts were reviewed, with 308 articles being selected for the full-reading stage.

Articles that covered practices for employee involvement in LM were chosen for the final sample. In this regard, 55 articles were included in the analysis sample. In addition, as a strategy to expand the sample of articles, the snowball approach (WOHLIN, 2014) was considered, adding three additional articles, resulting in 58 articles. Finally, based on a content analysis of the final sample of articles, 15 practices for employee involvement in LM were identified in the fourth step.

4.3.2 Phase 2: refinement and validation of the list of practices

Experts were conducted to refine and validate the preliminary list of practices. The empirical perspective of experts is considered vital to ensure the reliability of the list of practices (MOTA *et al.*, 2021). Three stages were considered for the refinement and validation of practices: (1) expert selection; (2) consultation with the experts; (3) analysis of experts' responses.

In the first step, 16 experts were selected, 6 academics (represented by the letter A) and 10 practitioners (represented by the letter P), as shown in Table 4.2. As a result, the number of experts selected is greater than the number of experts used in recent articles published in high-impact factor journals, as shown in Table 4.3.

Table 4.2 - Detail of expert sample

Expert	Summary of expertise	P	A
#e1	Professor and researcher with over ten years of experience in production management, operations, and LM.		X
#e2	Professor with over ten years of experience in operation management and LM.		X
#e3	Ph.D. in Industrial Engineering, professor and researcher with over ten years of experience in production management and operations and LM		X

Expert	Summary of expertise	P	A
#e4	Master's degree in Industrial engineering and a LM consultant with four years of experience.	X	
#e5	Ph.D. in Industrial Engineering and planning manager with seven years of experience.	X	
#e6	Continuous improvement engineer and planning and monitoring of the LM program with four years of experience in a large construction company.	X	
#e7	LM consultant with five years of experience in the industrial and service sectors.		X
#e8	General production manager with over ten years of experience with LM implementation and continuous improvement programs.	X	
#e9	Ph.D. in Industrial Engineering and senior project engineer with four years of experience in LM and continuous improvement programs.	X	
#e10	Ph.D. in Industrial Engineering and LM researcher with seven years of experience.		X
#e11	Lean coordinator with seven years of experience in LM projects.	X	
#e12	LM specialist coordinated a LM implementation for ten years and is a professor and LM consultant.		X
#e13	Top management with more than ten years of experience in projects and LM implementation.	X	
#e14	Production supervisor with four years of experience in continuous improvement programs.	X	
#e15	Production supervisor with seven years of experience in continuous improvement programs.	X	
#e16	LM consultant and top management with more than ten years of experience in projects and LM implementation.	X	

Source: Elaborated by the author

Table 4. 3 Comparison of the number of experts used in previous studies.

References	**Academics**	**Practitioners**	**Total**
Zhang et al. (2017)	0	5	5
Mota et al. (2021)	6	8	14
Prasad et al. (2020)	7	2	9
Callefi et al. (2022)	3	3	6
Godinho Filho et al. (2022)	6	8	14
Sonar et al. (2022)	0	9	9

Source: Elaborated by the author

In the second step, a questionnaire covering the title and description of the practices was sent by email to the 16 selected experts. This questionnaire also contained instructions on the need for experts to consider three main aspects during the analysis process: (1) the relevance of the practice to the topic studied; (2) the practice title/name; (3) the description of the practice. Finally, in the third step, the final list of 15 practices for employee involvement in LM was defined based on possible amendments made by the experts to the practices identified in the systematic literature review.

4.3.3 Phase 3: elaboration of the structural model

The ISM was used in the development of the structural model. This method is widely used in LM research (KALE *et al.*, 2022; PRASAD *et al.*, 2020). This use is explained by the ISM's capacity to facilitate the analysis of the interrelationships between each element, hence enabling the development of a structural model (AADITHYA *et al.*, 2021). Additionally, even though techniques like Decision-Making Trial and Evaluation Laboratory (DEMATEL) and ISM are comparable. However, DEMATEL covers twice as many comparisons as ISM, which could lead to incorrect results, primarily as a result of fatigue during the comparison matrix response process (BIANCO *et al.*, 2021).

Considering the guidelines proposed by Raj et al. (2008), ISM methodology includes the following steps (1) development of structural self-interaction matrix (SSIM); (2) development of initial reachability matrix (IRM); (3) development of final reachability matrix (FRM); (4) performing level partitions; and (5) derivation of ISM based model.

In the first step, the development of SSIM was carried out using experts' judgments. The sample of experts was the same as used in the phase of refinement and validation of practices, that is, 16 experts (Table 3). After that, a questionnaire containing the information required to build the SSIM was created, and each expert was required to assess the pair relationships between the practices. The following symbols were considered to complete the SSIM:

i. V: practice i positively affects practice j
ii. A: practice j positively affects practice i
iii. X: Practices i and j will help achieve each other.
iv. O: there is not a relationship between (i, j) practices

The second step contemplated the construction of the Initial Reachability Matrix (IRM). This matrix covers the conversion of SSIM to a binary matrix. To carry out this conversion, the following rules proposed by Watson (1978) were considered:

- If (i, j) entry in SSIM is V, then (i, j) entry in the initial reachability matrix becomes 1, and (j, i) entry becomes 0.
- If (i, j) entry in SSIM is A, then (i, j) entry in the initial matrix becomes 0, and (j, i) entry becomes 1.
- If (i, j) entry in SSIM is X, then (i, j) entry in the initial matrix becomes 1, and (j, i) entry also becomes 1.
- If (i, j) entry in SSIM is O, then (i, j) entry in the initial matrix becomes 0, and (j, i) entry also becomes 0.
- Diagonal elements are assigned 1 as both i and j are the same.

After that, in the third step, the FRM was developed considering a transitivity condition (WATSON, 1978). In this regard, if practice A is related to practice B and practice B is related to practice C, then it is necessary to attribute that there is a relationship between practices A and C. In this regard, this indirect influence existing between the practices is represented in the FRM by 1*.

In the fourth step, considering the developed FRM, performing level partitions are performed. In this process, the reachability set and antecedent set of each of the practices was initially identified, considering the guidelines proposed by Ruiz-Benitez et al. (2017). The reachability set encompasses the practice itself and all the practices that be impacted while the antecedent set encompasses the practice itself and all practices that impact this practice. Following that, the intersection set was defined, including the practice itself and the practices that have an impact on it and are impacted by it.

With the definition of reachability, antecedent, and intersection sets, it was possible to identify the level of each practice. Thus, it was initially established that the practices that presented the same intersection and reachability sets were at the first level. The practices that are already at the top level are discarded and the next level is analyzed. This process is repeated until the level of all practices is determined.

Finally, in the fifth step, the structural model was constructed from the level partitions and FRM. Furthermore, if there was a relationship between two practices in the FRM, then this relationship is represented in the structural model from an arrow that points from I and j.

4.3.4 Phase 4: development of a cluster diagram

The fuzzy MICMAC was used in the development of the cluster diagram. This approach has been widely used to complement the weakness of the ISM method (BIANCO *et al.*, 2021). This use is normally explained by the fact that while the ISM focuses on the binary analysis of the relationship between two practices, the fuzzy MICMAC allows an understanding of the intensity of the existing relationship (MOTA *et al.*, 2021).

Considering the guidelines proposed by Bhosale and Kant (BHOSALE; KANT, 2016), the fuzzy MICMAC approach includes the following steps (1) development of binary direct reachability matrix (BDRM); (2) construction of fuzzy direct reachability matrix (FDRM); (3) development of Fuzzy MICMAC stabilised matrix (FMSM); and (4) derivation of cluster diagram.

In the first step, by replacing the diagonal elements of the IRM with zeros, the BDRM is obtained. In addition, BDRM does not cover the transitivity instances considered above. Then, in the second step, a fuzzy scale (Table 4.4) was considered for constructing the FDRM. This scale is crucial because it makes it possible to identify the intensity of the relationship between the analyzed practices.

Table 4. 4 Linguistic terms for the relationship evaluation.

Strength	Value assigned	Several experts agreed that the factor i drive factor j
Null	0	0
Very low	0.10	1-3
Low	0.30	4-6
Medium	0.50	7-10
Hight	0.70	11-13
Very Hight	0.90	14-16
Completely	1.00	17 and above

Source: Adapted from Mohanty (2018).

In the third step, BDRM stabilization was achieved. The literature describes several fuzzy composition procedures, each with advantages and disadvantages (e.g., max product, max-average, and max-min). The max-min operator [Eq. (1)], proposed by Kandasamy et al. (2007), was chosen as the approach since it is considered to be more appropriate for the fuzzy MICMAC context (Mota *et al.*, 2021). The implementation in

MATLAB program, which allowed the definition of the FMSM, was carried out to increase the accuracy of the calculation process of this multiplication of fuzzy matrices.

$$T = U * V = MAX\, n\, [\min(x_{in}, y_{nj})] \quad (1)$$

Here, U = x_{in} and V= y_{nj}.

Together with the FMSM identification, the driving and dependence power levels of each practice were also determined. The driving power of a practice is determined by the sum of all values in the respective row, and the sum of all values in the respective column determines the dependence power of a practice.

Finally, in the fifth step, the cluster diagram was constructed. This diagram is defined from the values of driving power and dependence power, with practices organized into four groups: autonomous, dependent, linkage, and driver.

4.4 RESULTS

4.4.1 Validated list of essential employee involvement practice

Initially, with the RSL covering the analysis of 57 articles (for this review, a refinement was carried out in the selected articles with greater rigor regarding the impact of the journals, but there was no change in relation to the practices obtained in article 1), 15 employee involvement practices were identified. A complete description of each of the 57 papers' main goals and contributions can be available upon request. The 16 experts agreed with the 15 employee involvement practices in LM. Furthermore, their opinions were helpful in recommending some amendments on some practice´s descriptions. The validated list with the 15 practices is shown in Table 4.5.

Table 4. 5 Practices to employee involvement in LM

Practice	Cod.	Description	References
Guarantee that individual's behaviors follow companies' goals	P1	The company should guarantee that employees' behaviors are aligned with organization strategy (Gagnon *et al.*, 2008).	Gagnon et al. (2008).

Practice	Cod.	Description	References
Making job resources available	P2	The management should make available all the resources needed to perform a task. Resources refer to “physical, psychological, social, or organizational aspects of the job that may do any of the following: 1) be instrumental in accomplishing work goals; 2) reduce job demands; 3) foster individual growth and development” (Huo and Boxall, 2018).	Grigg (2010); Stelson et al. (2017); Huo and Boxall (2018); Dellve et al. (2018).
Promote employee-friendly policies	P3	The company should promote employee-friendly policies involving an enabling environment created for employees who wish to participate and are highly involved in lean-centered activities through interpersonal relationships onboard, quality of life at work, and work/personal life balance (Roslin *et al.*, 2019).	Boxall and Winterton (2018); Beraldin et al. (2019); Roslin et al. (2019); Malik and Abdallah (2020); Yuik et al. (2020); Benkarim and Imbeau (2021); Boxall and Huo (2022).
Management support	P4	Managers support workers in performing improvement tasks (Bergquist and Westerberg, 2014). An example of this support is the availability of financial and non-financial resources related to the implementation of Lean.	Bergquist and Westerberg (2014); Soetara et al. (2018); Roslin et al. (2019); Dellve et al. (2018); Rachman and Ratnayake (2019); Hernandez-Matias et al. (2020); Signoretti (2020); Tran et al. (2020); González-Boubeta et al. (2021); Tezel et al. (2021); Boxall and Huo (2022); Klein et al. (2022); Mathiyazhagan et al. (2022); Qureshi et al. (2022).
Intensive use of communication and feedback mechanisms	P5	Companies should use informal conversations and meetings to involve employees in improving day-to-day operations through informal discussions and meetings (Vicente *et al.*, 2015).	Assarlind (2015); Vicente et al. (2015); Roslin et al. (2019); Hernandez-Matias et al. (2020); Neirotti (2020); Signoretti (2020); Tran et al. (2020); Ahlstrand and Gautié (2022); Klein et al. (2022).
Education programs, training, and personal development	P6	Companies should provide employees with programs that promote knowledge and self-development. These programs can be internal, carried out by consultancies, or continuous training sponsored by the company with external or postgraduate studies (McLean *et al.*, 2017; Stadnicka and Antosz, 2015)	Stadnicka and Antosz (2015); McLean et al. (2017); Moica et al. (2019); Pereira et al. (2018); Rachman and Ratnayake (2019); Roslin et al. (2019); Sisson (2019); Chen et al. (2020); Hernandez-Matias et al. (2020); Jing et al. (2020); Kumar and Mathiyazhagan (2020); Signoretti (2020); Tran et al. (2020); Benkarim and Imbeau (2021); Van Assen (2021); Ahlstrand and Gautié (2022); Azalanzazllay et al. (2022); Boxall and Huo (2022); Potter (2022); Qureshi et al. (2022).

Practice	Cod.	Description	References
Continuous development of employee´s leadership skills	P7	The company should develop leadership skills (communication, listening, and feedback). This is important because a higher degree of trust in leadership leads to proactive behaviors by frontline employees, encouraging them to use autonomy in their day-to-day tasks to seek out and make systematic improvements to work processes (Anand *et al.*, 2012).	Anand et al. (2012); Godinho Filho et al. (2016); Lodgaard et al. (2016); Dellve et al. (2018); Soetara et al. (2018); Sisson (2019); Ahlstrand and Gautié (2022); Azalanzazllay et al. (2022).
Use of Kaizen events	P8	Kaizen events are events to solve problems regularly and increase workers' participation in making improvements. Impressed by the outcome, the employees strive to keep the event alive through daily kaizen methods. Corporate culture thrives, leading to greater employee empowerment (Vo *et al.*, 2019)	Wickramasinghe and Wickramasinghe (2017); Rachman and Ratnayake (2019); Vo et al. (2019); Kumar and Mathiyazhagan (2020); Wickramasinghe and Chathurani (2020).
Use of Reward-based incentives	P9	Programs implemented to reward workers, in addition to fixed remuneration (salary and annual raises), with variable pay that depends on performance, increasing collective effort, professionalism, and flexibility of workers (Wickramasinghe and Wickramasinghe, 2016). Employee involvement can be improved by giving achievement recognition and innovation reward (Soetara *et al.*, 2018).	Brkic and Tomic (2016); Rothstein (2016); Wickramasinghe and Wickramasinghe (2016); McLean et al. (2017); Boxall and Winterton (2018); Soetara et al. (2018).
Provide career advancement opportunities for employees	P10	Perception of career opportunities to employees' growth future in the organization based on their merit and performance (Bhattacharya, 2015).	Bhattacharya (2015).
Drive suggestion programs	P11	These programs create an environment conducive to employee involvement by encouraging rewards-based improvement suggestions (Roslin *et al.*, 2019).	Godinho Filho et al. (2016); Rothstein (2016); Roslin et al. (2019); Chopra and Fernando (2020); Kumar and Mathiyazhagan (2020); Neirotti (2020); Beraldin et al. (2022).

Practice	Cod.	Description	References
Empowerment (job autonomy)	P12	Companies should empower employees to perform and operate correctly, as liberty allows them to utilize their creative decision-making and managing objectives to improve processes (Roslin *et al.*, 2019).	Boxall and Winterton (2018); Roslin et al. (2019); Van Assen and De Mast (2019); Rupasinghe and Wijethilake (2020); Signoretti and Sacchetti (2020); Ahlstrand and Gautié (2022); De Koeijer et al. (De Koeijer *et al.*, 2022); Narayanan et al. (2022).
Promotion of teamwork	P13	Employee involvement implies that employees work in a group where each member has some level of input in the group's decisions allowing them to be taken in a more systematic, integrated, and analytical way (Grigg, 2010).	Grigg (2010); Rothstein (2016); Godinho Filho et al. (2016); De Vries and Van der Poll (2018); Roslin et al. (2019); Chen et al. (2020); Neirotti (2020); Signoretti (2020); Beraldin et al. (2022); Narayanan et al. (2022).
Multifuncional employee (job rotation)	P14	It is a program that ensures the presence of multifunctional workers with enhanced technicalities by training them on different machines and other functions (Talib *et al.*, 2020).	Rothstein (2016); Soetara et al. (2018); Hernandez-Matias et al. (2020); Signoretti and Sacchetti (2020);Talib et al., 2020, Narayanan et al. (2022).
Encourage innovation and Technologies	P15	It refers to using information technology (IT) systems and active methodologies as a source of knowledge to inspire employees to engage in lean changes (Pereira *et al.*, 2018; Stadnicka and Antosz, 2015).	Stadnick and Antosz (2015); Berlec et al. (2017); Boxall and Winterton (2018); Pereira et al. (2018); Moica et al. (2019); Pereira and Liker (2021).

4.4.2 ISM results

Following the methodological foundations of the ISM method, the relationship between the 15 employee involvement practices was analyzed according to experts' judgments. Thus, the SSIM was initially developed (Table 4.6), and later the IRM (Table 4.7) and the FRM (Table 4.8) were built. Finally, the level partition (Table 4.9) of each of the practices was determined, and the ISM based model was built, as shown in Figure 4.2.

Table 4.6 - Strctural Self-Interection Matrix (SSIM)

Practices Nº	P15	P14	P13	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1
P1	O	O	O	A	A	A	A	V	A	A	A	A	A	O	X
P2	X	O	O	V	V	O	O	V	O	O	O	X	O	X	
P3	O	V	X	X	X	A	V	V	X	A	X	X	X		
P4	A	V	V	V	V	X	O	V	X	A	X	X			
P5	X	V	V	V	X	V	V	V	V	X	X				
P6	X	X	V	V	V	V	V	V	X	X					
P7	O	V	X	A	V	X	O	V	X						
P8	O	A	X	A	X	O	A	X							
P9	O	O	V	O	V	X	X								
P10	O	V	X	X	V	X									
P11	X	O	X	A	X										
P12	V	X	X	X											
P13	O	X	X												
P14	O	X													
P15	X														

Source: Elaborated by the author

Table 4.7 - Initial reachability matrix (IRM)

Practices Nº	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**
P1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
P2	0	1	0	1	0	0	0	1	0	0	1	1	0	0	1
P3	1	0	1	1	1	0	1	1	1	0	1	1	1	1	0
P4	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0
P5	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
P6	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
P7	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0
P8	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0
P9	1	0	0	0	0	0	0	1	1	1	1	0	1	0	0
P10	1	0	1	1	0	0	1	0	1	1	1	1	1	1	0
P11	1	0	1	0	1	0	0	1	0	0	1	0	1	0	1
P12	1	0	1	0	0	0	1	1	0	1	1	1	1	1	1
P13	0	0	1	0	0	0	1	1	0	1	1	1	1	1	0
P14	0	0	0	0	0	1	0	1	0	0	0	1	1	1	0
P15	0	1	0	1	1	1	0	0	0	0	1	0	0	0	1

Source: Elaborated by the author

Table 4.8 - Final reachability matrix (FRM)

Practices No	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
P1	1	0	0	0	0	0	0	1	0	0	1*	0	1*	0	0
P2	1*	1	1*	1*	1*	1*	1*	1	0	1*	1	1	1*	1*	1
P3	1	0	1	1	1	1*	1	1	1	1*	1	1	1	1	1*
P4	1	0	1	1	1	1*	1	1	1*	1	1	1	1	1	1*
P5	1	1*	1	1	1	1	1	1	1	1	1	1	1	1	1
P6	1	1*	1	1	1	1	1	1	1	1	1	1	1	1	1
P7	1	0	1	1	1*	1	1	1	1*	1	1	1*	1	1	1*
P8	1*	0	1*	0	1*	0	1*	1	0	1*	1	1*	1	1*	1*
P9	1	0	1*	1*	1*	0	1*	1	1	1	1	1*	1	1*	1*
P10	1	0	1	1	1*	1*	1	1*	1	1	1	1	1	1	1*
P11	1	1*	1	1*	1	1*	1*	1	1*	1*	1	1*	1	1*	1
P12	1	1*	1	1*	1*	1*	1	1	1*	1	1	1	1	1	1
P13	1*	0	1	1*	1*	1*	1	1	1*	1	1	1	1	1	1*
P14	1*	0	1*	1*	1*	1	1*	1	1*	1*	1*	1	1	1	1*
P15	1*	1	1*	1	1	1	1*	1*	1*	1*	1	1*	1*	1*	1

Source: Elaborated by the author

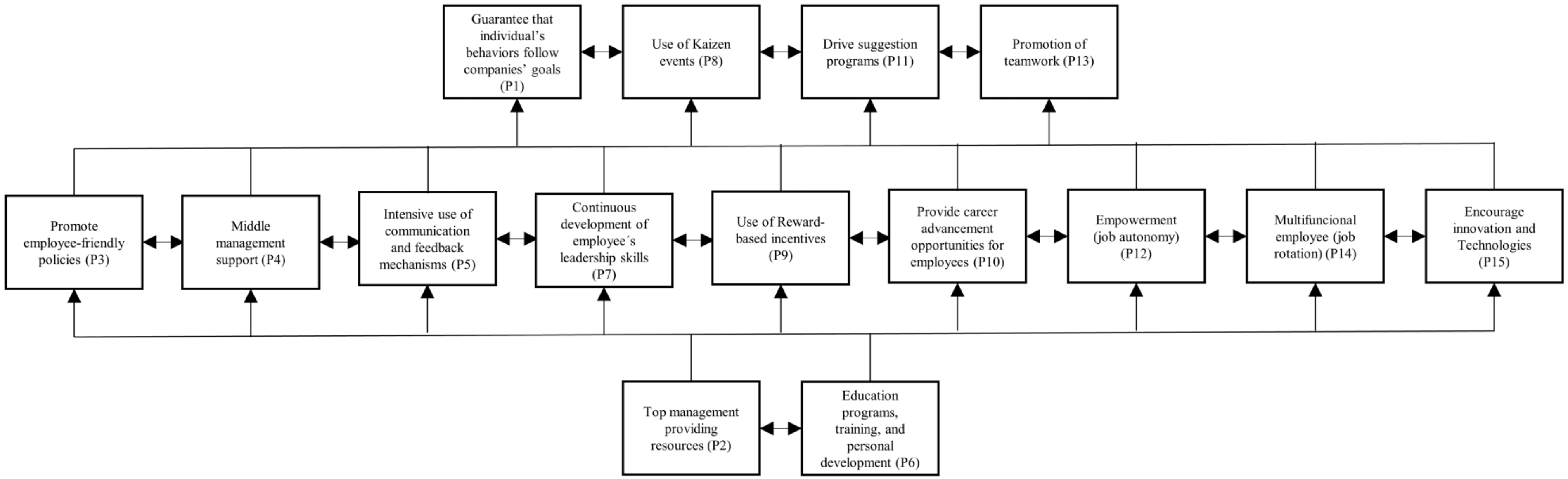
Table 4.9 - Level partitions

Practices Nº	Reachability Set	Antecedent Set	Intersection Set	Level
P1	1, 8, 11, 13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 8, 11, 13	III
P2	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15	2, 4, 5, 6, 11, 12, 15	2, 5, 6, 11, 12, 15	I
P3	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14. 15	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14. 15	II
P4	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	II
P5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	II
P6	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15	I
P7	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	II
P8	1, 3, 5, 7, 8, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 3, 5, 7, 8, 10, 11, 12, 13, 14, 15	III
P9	1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15	3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15	II
P10	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	II
P11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	III
P12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	II
P13	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	III

Practices Nº	Reachability Set	Antecedent Set	Intersection Set	Level
P14	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	II
P15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	II

Source: Elaborated by the author

Figure 4. 2 - Developed ISM model



Source: Elaborated by the author

Figure 4.2 shows that the ISM model has three levels of hierarchy. The first level with two practices (P2 and P6), the second level with nine practices (P3, P4, P5, P7, P9, P10, P12, P14, and P15), and the third level with four practices (P1, P8, P11, and P13). This structure of levels of the ISM model allows the visualization of the hierarchy between the analyzed practices.

In this regard, the practices of the first level are those with the highest level of direct influence on the practices of the other levels. Second-level practices have an intermediary role, since they directly influence third-level practices, but are influenced by first-level practices. Finally, third-level practices are those with low positive influence and high dependence on other practices.

4.4.3 Fuzzy MICMAC results

The BDRM was initially developed using the fuzzy MICMAC approach (Table 4.10). The FDRM (Table 4.11) and the FMSM (Table 4.12) were subsequently constructed. The 15 employee participation practices were then categorized into four clusters by considering the driving power and dependence power values, as shown in Figure 4.3.

Table 4.10 - Binary direct reachability matrix (BDRM)

Practices Nº	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
P1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
P2	0	0	0	1	0	0	0	1	0	0	1	1	0	0	1
P3	1	0	0	1	1	0	1	1	1	0	1	1	1	1	0
P4	1	0	1	0	1	0	1	1	0	1	1	1	1	1	0
P5	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1
P6	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1
P7	1	0	1	1	0	1	0	1	0	1	1	0	1	1	0
P8	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
P9	1	0	0	0	0	0	0	1	0	1	1	0	1	0	0
P10	1	0	1	1	0	0	1	0	1	0	1	1	1	1	0
P11	1	0	1	0	1	0	0	1	0	0	0	0	1	0	1
P12	1	0	1	0	0	0	1	1	0	1	1	0	1	1	1
P13	0	0	1	0	0	0	1	1	0	1	1	1	0	1	0
P14	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0
P15	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0

Source: Elaborated by the author

Table 4.11 - Fuzzy direct reachability matrix (FDRM)

Practices Nº	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
P1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Practices Nº	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
P2	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,7	0,0	0,0	0,5	0,9	0,0	0,0	0,7
P3	0,5	0,0	0,0	0,5	0,5	0,0	0,5	0,7	0,7	0,0	0,9	0,7	0,9	0,5	0,0
P4	0,5	0,0	0,5	0,0	0,5	0,0	0,7	0,7	0,0	0,5	0,7	0,7	0,9	0,9	0,0
P5	0,5	0,0	0,5	0,7	0,0	0,7	0,7	0,5	0,7	0,5	0,7	0,7	0,7	0,7	0,5
P6	0,7	0,0	0,7	0,5	0,5	0,0	0,7	0,7	0,5	0,9	0,9	0,9	0,5	0,9	0,5
P7	0,7	0,0	0,7	0,5	0,0	0,7	0,0	0,5	0,0	0,7	0,7	0,0	0,7	0,7	0,0
P8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,5	0,0	0,0
P9	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,5	0,9	0,0	0,5	0,0	0,0
P10	0,7	0,0	0,5	0,5	0,0	0,0	0,5	0,0	0,5	0,0	0,7	0,7	0,7	0,5	0,0
P11	0,5	0,0	0,7	0,0	0,3	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,5	0,0	0,5
P12	0,5	0,0	0,7	0,0	0,0	0,0	0,5	0,7	0,0	0,7	0,9	0,0	0,7	0,7	0,5
P13	0,0	0,0	0,5	0,0	0,0	0,0	0,5	0,9	0,0	0,5	0,7	0,7	0,0	0,5	0,0
P14	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,5	0,0	0,0	0,0	0,7	0,5	0,0	0,0
P15	0,0	0,50	0,00	0,30	0,70	0,50	0,00	0,00	0,00	0,00	0,50	0,00	0,00	0,0	0,0

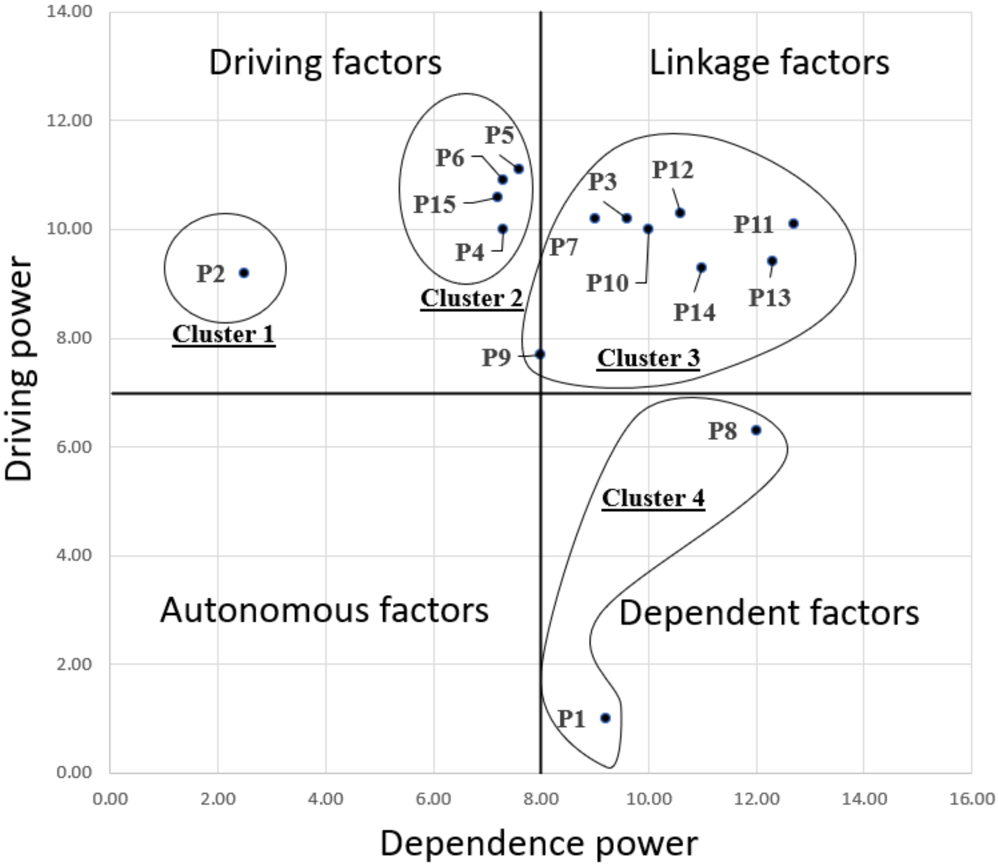
Source: Elaborated by the author

Table 4.12 Fuzzy MICMAC stabilised matrix (FMSM)

Practices Nº	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	Row Total
P1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,5	0,0	0,0	1,0
P2	0,5	0,5	0,7	0,3	0,7	0,5	0,7	0,7	0,0	0,7	0,9	0,7	0,9	0,9	0,5	9,2
P3	0,7	0,0	0,7	0,7	0,5	0,7	0,7	0,9	0,7	0,7	0,9	0,7	0,9	0,9	0,5	10,2
P4	0,7	0,0	0,7	0,7	0,5	0,7	0,7	0,9	0,7	0,7	0,9	0,7	0,9	0,7	0,5	10,0
P5	0,7	0,5	0,7	0,5	0,7	0,7	0,7	0,9	0,7	0,9	0,9	0,9	0,9	0,9	0,5	11,1
P6	0,7	0,5	0,7	0,7	0,7	0,7	0,7	0,9	0,7	0,7	0,9	0,7	0,9	0,9	0,5	10,9
P7	0,7	0,0	0,7	0,5	0,5	0,5	0,7	0,9	0,7	0,9	0,9	0,9	0,9	0,9	0,5	10,2
P8	0,5	0,0	0,7	0,0	0,3	0,0	0,5	0,9	0,0	0,5	0,7	0,7	0,5	0,5	0,5	6,3
P9	0,7	0,0	0,7	0,5	0,3	0,0	0,5	0,9	0,5	0,5	0,7	0,7	0,7	0,5	0,5	7,7
P10	0,7	0,0	0,7	0,5	0,5	0,7	0,7	0,9	0,7	0,7	0,9	0,7	0,9	0,9	0,5	10,0
P11	0,5	0,5	0,5	0,7	0,7	0,7	0,7	0,9	0,7	0,5	0,9	0,7	0,9	0,7	0,5	10,1
P12	0,7	0,5	0,7	0,5	0,7	0,7	0,5	0,9	0,7	0,7	0,9	0,7	0,9	0,7	0,5	10,3
P13	0,7	0,0	0,7	0,5	0,5	0,7	0,5	0,7	0,7	0,7	0,9	0,7	0,9	0,7	0,5	9,4
P14	0,7	0,0	0,7	0,5	0,5	0,0	0,7	0,9	0,5	0,9	0,9	0,9	0,7	0,9	0,5	9,3
P15	0,7	0,0	0,7	0,7	0,5	0,7	0,7	0,7	0,7	0,9	0,9	0,9	0,9	0,9	0,7	10,6
Column total	9,2	2,5	9,6	7,3	7,6	7,3	9,0	12,0	8,0	10,0	12,7	10,6	12,3	11,0	7,2	

Source: Elaborated by the author

Figure 4.3 - Cluster diagram from the Fuzzy MICMAC.



Source: Elaborated by the author

Figure 4.3 shows that the cluster diagram presents practices in three of the four clusters. Two practices are in the dependent cluster (P1 and P8), eight practices are in the linkage cluster (P3, P7, P9, P10, P11, P12, P13, and P14), and five practices are in the driving cluster (P2, P4, P5, P6, and P15). Although the P9 practice is on the border between the driving and linkage clusters, it was considered more appropriate to consider it as being the linkage factor, since the driving power value of this practice is lower than that of other driving practices.

Because 13 of the 15 practices are positioned around the top of the x-axis, it is clear that the majority of practices have a significant driving power value. Despite the fact that some practices are more crucial than others, 13 of the 15 practices can positively influence employee involvement in LM efforts. Furthermore, because there are no practices in the quadrant of autonomous factors, all practices appear related. Since the analyzed practices are related, this finding confirms that applying the ISM technique is appropriate for this study.

Another point worth mentioning is that the fuzzy MICMAC findings indicate four major group of practices. The first and second groups cover the driving variables, with P2 allocated to one group and the other practices allocated to another. The third cluster addresses the linkage factors. Finally, the fourth group addresses the dependent variables. As a result, the identified cluster organization allows for a better comprehension of the ISM model (Figure 2), in which these practices are organized into four groups. In this regard, the results of the ISM method and the fuzzy MICMAC approach can be discussed together.

4.5 DISCUSSION: A FRAMEWORK TO INVOLVE EMPLOYEES IN LEAN MANUFACTURING EFFORTS

Analyzing Figures 4.2 and 4.3 and considering the literature on LM, we propose that employee involvement in an organization should follow a path composed by 4 major steps:

(1) Step 1: getting the necessary resources;

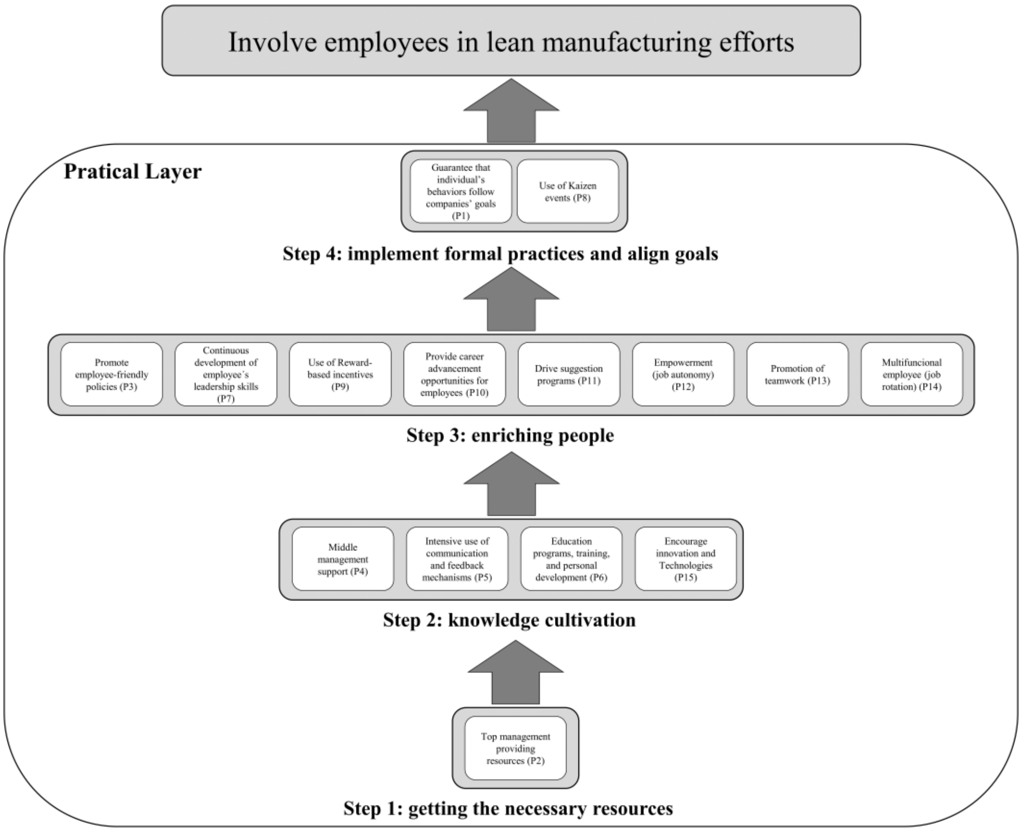
(2) Step 2: knowledge cultivation;

(3) Step 3: enriching people; and,

(4) Step 4: implement formal practices and align goals.

These four steps are shown in Figure 4.4 and are discussed below. The nomenclature of each of the steps is based on the characteristics of the practices presented in the step, as well as from an analysis of the LM literature.

Figure 4.4 - A framework with the three main steps to involve employees in lean efforts.



Source: Elaborated by the author

4.5.1 Step 1 - getting the necessary resources

The first step to involve employees in lean efforts involves getting the necessary resources, covering only the P2 (management providing resources) practice. This practice corresponds to the first level of the structural model and has a high value of driving power and low dependence power. According to Hou and Boxall (2018), employee involvement in LM depends on the organization's managers' available resources. This finding is also supported by Bergquist and Westerberg (2014) and Grigg (2010), who emphasize the importance of management resources in ensuring employees are trained and involved in LM activities.

This finding supports the premise that organizations interested in guaranteeing employee involvement in LM initiatives must ensure that the appropriate resources are available to support this change management process. According to Huo and Boxall (2018), besides financial resources, it is critical to guarantee that employees who participate in LM efforts have a decreased workload of other activities inside the organization.

4.5.2 Step 2 - knowledge cultivation

The second step in including employees in lean efforts is to cultivate knowledge. This level is comprised of four practices: P4 (middle management support), P5 (intensive use of communication and feedback mechanisms), P6 (education programs, training, and personal development), and P15 (encouragement innovation and technologies). All of the practices in this step are classified as driving factors since they have a high driving power and a low dependence power.

Knowledge cultivation aspects are regarded as critical to the success of LM initiatives (DOMBROWSKI; MIELKE; ENGEL, 2012). To facilitate LM efforts, businesses must establish a structure for developing and sharing knowledge throughout the firm (AGYABENG-MENSAH *et al.*, 2021). Therefore, strategies such as encouraging innovation (PEREIRA; LIKER, 2021), information sharing (KLEIN *et al.*, 2022), and training programs (QURESHI *et al.*, 2022) become critical for knowledge provision. Furthermore, BERGQUIST; WESTERBERG (2014) state that managers encourage education, training, and personal development initiatives in LM initiatives.

4.5.3 Step 3 - Enriching people

The third step to involve employees in the lean manufacturing effort is related to practices to “enrich” people within organization. This step covers practices of the level II of the structural model. eight practices compose this level. P3 (promote employee-friendly policies), P7 (continuous development of employee´s leadership skills), P9 (use of reward-based incentives), P10 (provide career advancement opportunities for employees), P11 (drive suggestion programs), P12 (empowerment), P13 (promotion of teamwork), and P14 (multifunctional employee). All of these practices have in common efforts to improve employees experience in their jobs. The existence of several practices in this same group demonstrates that aspects of HRM must be considered as a whole to promote an effective effort for employee involvement in lean manufacturing. This finding is in line with the literature, as several authors point out the importance of practices related to HRM from the perspective of employee involvement (NEIROTTI, 2020; SAKS, 2022). HRM practices can be considered indirect variables that influence employee involvement, since this group is in the middle layer. Friendly policies (BOXALL; HUO, 2022; ROSLIN *et al.*, 2019), leadership development (DELLVE *et al.*, 2018), empowerment (VAN ASSEN; DE MAST, 2019), reward-based incentives (SOETARA *et al.*, 2018), and other HRM-related factors are thus critical to the lean implementation process.

The Fuzzy MICMAC analysis (Figure 4.3) indicated that the eight practices in this step are considered linkage factors. The linkage practices have a high driving and dependence power. This cluster of practices is considered unstable because any action on them affects other practices and has a feedback effect on them. Thus, it appears that the aspects of Enriching people have a cause-and-effect function, as they directly influence various other practices while simultaneously being dependent on the practices of the first two levels.

4.5.4 Step 4 - Implement operational practices

After getting the necessary resources, and enriching people, it is time to implement more formal employee involvement techniques and align goal. This fourth group covers two practices, namely P1 (align individual's goals according to companies' goals) and P8 (use of kaizen events). The practices of this group cover different aspects of the practical reality of lean implementation. P1 covers the need for employees to be engaged with the objectives and goals defined by the company (GAGNON *et al.*, 2008). P8 contemplates the importance of holding kaizen events to promote employee involvement (VO *et al.*, 2019).

The Fuzzy MICMAC analysis (Figure 4.3) indicated that these two practices are dependent factor, which have weak driving power, but strong dependence power. Therefore, these practices present a significant dependence on other practices. For example, Vo et al. (2019) point out that aspects such as management support and employee incentives should be considered despite the importance of kaizen events to promote employee involvement. Companies must then not only carry out kaizen events but also ensure that employees perceive active management involvement and feel motivated and rewarded for their participation.

Another aspect to highlight about the practices in this step is that they are closely related to the Hoshin Kanri method. Tortorella et al. (2019) emphasize that one of the main concepts of using Hoshin Kanri in the LM context is that employees involved in the LM activities must have their goals aligned with the strategic guidelines provided by the firm. Furthermore, Mothersell et al. (2008) state that, according to Hoshin Kanri, the utilization of kaizen events is vital to provide proper organizational learning, given to its potential for encouraging employee involvement.

4.6 CONCLUSION

Fifteen fundamental practices were identified based on an extensive literature review. Then, empirical application of the ISM method and the Fuzzy MICMAC technique were employed to establish contextual relationships and classify these practices based on their driving and dependence powers. This matrix provides insights to management to understand the relative importance and interdependence among practices for increasing employee involvement in lean manufacturing. Besides, we also proposed a framework with a path to guide employee involvement in lean manufacturing efforts. The Research contributions and implications, limitations, and future research are discussed below.

4.6.1 Research contributions and implications

This study bears significant contributions and implications for managers and researchers alike. In this regard, this section presents the contributions and implications of this research.

4.6.1.1 Theoretical contributions and implications

The impact of soft factors on implementing lean manufacturing is widely discussed in the literature. Aspects such as leadership (BIANCO *et al.*, 2021), employee motivation (JING, LUO, *et al.*, 2020), training/learning/knowledge sharing (TORTORELLA *et al.*, 2020), among others, have been addressed in recent year. One of these soft lean practices is employee involvement, which several authors consider an important practice for lean manufacturing (GAIARDELLI *et al.*, 2019; LEITE *et al.*, 2022). However, despite the importance of employee involvement, QURESHI et al.

(2022), through a MICMAC approach, classifies this practice as a dependent factor, demonstrating its effect on lean initiatives depends on other practices. In this regard, there is a lack of research covering a study of practices that have the potential to enhance employee involvement in a lean context. Thus, to the best of our knowledge, our paper is the first to present an in-depth study concerning practices to involve employees in lean manufacturing.

Another important theoretical contribution of the study is developing a mixed-method approach to this topic. We not only presented a list of 15 practices related to employee involvement presented but also, through, respectively, the ISM and Fuzzy MICMAC, showed a structural model and a cluster diagram. These two artifacts enabled an understanding of the rationale for employee involvement in a lean context. In addition, we proposed a framework for companies to involve employees in lean manufacturing efforts. To best of our knowledge, any framework with this goal is available in Lean literature.

Regarding OCM theory, the main OCM models, as indicated in Section 2, provide a generalist perspective on the change management process because they do not address a specific issue, such as implementing a continuous improvement approach. Furthermore, none of these models propose a path to guide the change that should occur in organizations implementing employee involvement practices in a Lean Manufacturing environment.

In theoretical terms, based on the proposition of the 4-step model, our article contributes to the literature by systematizing a path for adopting practices to involve employees in LM efforts. In addition, for constructing the proposed framework, the principles of OCM theory were considered. Despite previous research related to LM implementation proposing a change management framework (e.g. LASTRA et al. (2019), ALMANEI et al. (2018), and NORDIN et al. (2012)), none of these models focus on employee involvement. This consideration of the OCM theory allowed the proposed framework to present a more practical nature, mainly by organizing the order of adoption of the practices by steps.

4.6.1.2 Management contributions and implications

In a practical context, managers can, from the structural model and the cluster diagram, obtain an understanding of which practices should be prioritized to promote employee involvement. This practical importance of the proposed model is valid since the validation of the practices and the judgments of the relationship between them take into account the opinion of a relevant sample of academics and practitioners experts in lean manufacturing. Besides, our framework can guide companies to involve their employees in lean manufacturing efforts.

In this regard, the management efforts toward employee involvement must be oriented concerning resource availability. These practices not only have the potential to directly influence the effectiveness of employee involvement but also enhance the effect generated by HRM and lean practices.

4.6.2 Limitations and future research directions

The limitations of the research work, which might have narrowed the insight into the issues presented in this study, are discussed in this section. Every study faces various constraining factors that limit the extent and scope of the research and its results. It is important to highlight these factors related to this study for future studies to consider them and define future research agendas.

Tthis study was primarily focused on the manufacturing sector; the implementing practices may be different for other sectors that need to be ranked. Thus, further research is required to provide added insights into the effect of employee involvement on the performance of organizations operating in other sectors. This will open an opportunity to understand the role that industry characteristics may have on the effect of employee involvement on the organization’s performance.

Finally, future studies may be conducted to statistically validate the proposed model using the structural equation modeling (SEM) technique. ISM’s competency to develop a primary model, whereas SEM provides path coefficients for the different relationships between the practices.

5 EMPLOYEE INVOLVEMENT IN LEAN MANUFACTURING: A MEASUREMENT SCALE

After developing a structural model capable of showing which practices should be prioritized to promote employee involvement, the need was felt to be able to measure them so that, within this hierarchy, managers can understand which practices are more advanced than others in their implementation, thus refining the decision-making capacity of which practices to prioritize to be better worked on in the company. This chapter reports developing and validating multi-item measurement scales to reflect employee involvement in lean manufacturing.

5.1 INTRODUCTION

The positive influence of employee involvement for the successful implementation and sustainability of lean, and consequently the improvement in the performance of companies, is already well proven in literature (AHMAD; SCHROEDER; SINHA, 2003; GODINHO FILHO; GANGA; GUNASEKARAN, 2016). However, it is also known that the literature still neglects human resource practices, such as employee involvement in favor of the study and application of technical practices related to lean such as quick-change tools, leveling, Kanban, streaming, value flow mapping, visual management, among others (ANGELIS et al., 2011, TORTORELLA; FOGLIATTO, 2014, NEGRÃO et al., 2017, VIVARES-VERGARA et al., 2016, ONOFREI et al., 2019).

Although the lean concept is widely accepted as a set of tools, methods, and techniques, the employee is the main factor for this system's success. Developing a culture of continuous improvement is not enough without fundamental respect for people. That is why a common saying in lean states that it is necessary to “develop people and then create products” because people bring the system to life by working, solving problems, developing and growing together, and, consequently, respecting people and employee engagement are determinations of the success of these initiatives (VUKADINOVIC et al., 2019).

Therefore, having trained employees responsible for quality and continuous improvement, collecting data to measure possible discrepancies in the process, and making decisions about their work benefit companies with a high degree of commitment.

That is why employee involvement and the establishment of participatory goals are essential for the successful implementation and sustainability of lean (VAN ASSEN, 2021).

However, no tool is found in the literature to assist managers in identifying their employees' level of involvement in lean manufacturing. Then, practices are implemented to increase involvement, but without an instrument to measure if the increased level of participation was carried out. Van Assen (2021) stresses that no instruments are developed exclusively to measure involvement. Besides being able to identify the level of employees' involvement, measurement tools help managers make decisions about which practices need investment and attention, providing more significant possibilities to increase this involvement (WRIGHT et al., 2017) and must pass new and rigorous reliability and validity testing process (FORZA, 2002). Therefore, this work seeks to answer the following research question:

How to measure employee involvement in lean implementation?

The purpose of this research is to create a measurement scale that accurately reflects the level of employee involvement in lean manufacturing. This will provide a validated instrument for future studies and aid in decision making regarding the implementation of lean practices. Ultimately, the goal is to increase employee participation and involvement in maintaining and implementing lean manufacturing.

The paper is structured in the following way: Section 5.2 outlines the research method used. This methodology is then utilized in Section 5.3 where a measurement scale is proposed to evaluate the practices of employee involvement in lean manufacturing. Session 5.4 involves discussions about the development and validation of the applied scale. Lastly, Section 5.5 provides the overall conclusions of the study, as well as its theoretical and managerial contributions.

5.2 RESEARCH METHOD

The development of empirical research must overcome the challenges of reducing errors, providing greater data robustness, and guaranteeing the constructs' reliability and validity (MENOR; ROTH, 2007). Therefore, the scale development in this study followed the sequence of steps proposed by DeVellis (2022), Lambert and Newman (2022), and

MacKenzie et al. (2011) adapted for the context of employee involvement. These steps are illustrated in Figure 5.1.

This section presents just an overview of the research method employed. We left some details of the research method to be presented together with the proposition of the scale (section 5.4) due to the following reasons (GONELLA et al., 2023):

- Comprehensive Presentation: This approach helps readers understand the link between the research design and the findings, enabling them to evaluate the validity and reliability of the results more effectively.

- Contextual Understanding: Providing an overview of the research method before presenting detailed results helps readers grasp the main characteristics, rationale, and specific research questions of the study, enhancing the interpretability and applicability of the findings.

- Efficiency/Reducing Repetition: Presenting methodological details and results in a single section improves the paper's coherence and readability by avoiding repetition and unnecessary back-and-forth between sections.

- Tailoring to Scale Proposals: Presenting methodological details and results together aligns with the specific requirements of scale development papers, allowing for a seamless presentation of the scale's development process, psychometric properties, and observed outcomes. This procedure is typically used in papers dealing with scale development, such as Kauppi and Luzzini (2022), Costa et al. (2021), and Nguyen et al. (2019).

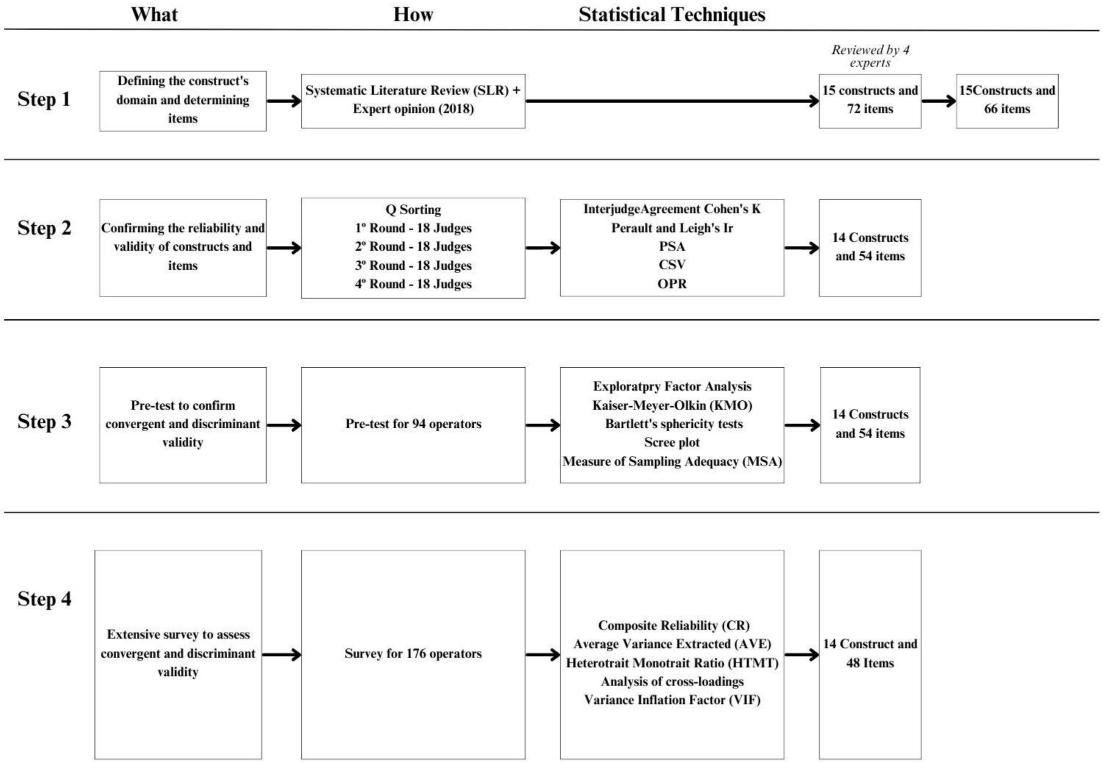
The first step involved map the constructs and the initial items of the scale. We performed a systematic literature review (SLR) about practices for employee involvement in lean manufacturing. We identified a preliminary list of employee involvement practices (MEDEIROS et al. (2023). The main result is a list of 15 employee involvement practices in lean manufacturing and 72 items taken from literature (Appendix 1). Four experts in the lean manufacturing field reviewed practices and items. This review was essential to evaluate the practices and items semantically and eliminate confusing or repetitive items. After such revision, all 15 employee involvement practices remained. However, six items were removed, leaving 66 items.

The second step involved four rounds with 72 experts (selecting judges was that they had prior knowledge of lean manufacturing) to classify the constructs and items. According to Menor and Roth (2007), the analysis of each round used an inter-rater reliability estimator. Each round was analysed using three inter-rater reliability estimators: inter-judge agreement percentage, Cohen's kappa, and Perrault and Leigh's Ir. In addition to ensuring reliability, we assessed substantive face validity (MENOR; ROTH, 2007) using validity estimators: the proportion of substantive agreement (PSA) and the coefficient of substantive validity (CSV). Finally, we used the overall placement ratio (OPR) to detect measurement errors. After this step, 14 employee involvement practices and 54 items remained.

The third step involved the application of a pre-test using non-probability sampling of 83 operators. The survey questionnaire was structured in three sections: the first section displayed the informed consent form; the second section gathered respondents' demographic characteristics; and the third section gathered information regarding the level of employee involvement in lean manufacturing. A seven-point Likert scale was used (from 1 = strongly disagree to 7 = strongly agree). Thus, respondents were asked to choose their level of agreement with the assertions offered for each construct. This pre-test was analysed using exploratory factor analysis (EFA) to evaluate the convergent and discriminant validity. None of the employee involvement practices and items were removed in this step.

The fourth step involved applying a survey (APPENDIX 2) with operators from five industries distributed in the north and southeast regions of the Brazilian national territory through non-probability sampling. The survey questionnaire was applied between April and August 2023, resulting in 206 responses. We identified 30 multivariate outliers based on the Z-score values (FAULKENBERRY, 2022). Thus, we obtained a final sample of 176 respondents. The results were analysed using Confirmatory Factor Analysis (CFA). The final step left 14 employee involvement practices and 48 items.

Figure 5.1 - stages in the methodological process



Source: Adapted by Gonella et al. (2023)

5.3 THE PROPOSED MEASUREMENT SCALE TO ASSESS PRACTICES FOR EMPLOYEE INVOLVEMENT IN LEAN MANUFACTURING

5.3.1 Step 1: Specifying the construct domains and generate items

The first step in developing better measures involves specifying the domains of the constructs. To do so, a Systematic Literature Review (SLR) was conducted to enable the identification of a preliminary list of employee involvement practices according to Medeiros et al. (2023) and chapter three of this thesis (see Table 5.1). The main result is a list of 15 employee involvement practices in lean manufacturing: "Guarantee that individual's behaviors follow companies' goals"; "creating improvement teams for group decision-making"; "education programs, training, and personal development"; "promoting empowerment and autonomy to employees"; "management support"; "continuous development of employee's leadership skills"; "encouraging innovation and technologies"; "intensive use of communication and feedback mechanism"; "making job resources available"; "promoting employee-friendly policies; providing career advancement opportunities to employees"; "use of reward-based incentives"; "develop multifunctional workers"; "drive suggestion programs"; and use of Kaizen events.

Furthermore, items that capture the domain as specified must be generated. For this, employee involvement in lean manufacturing literature was revisited to identify assertions used in previous studies. As a result, at the end of these two steps, 15 practices and 72 items were used to measure this concept.

Moreover, their definitions were analysed in the specialist panel, with 4 Ph.D. professors specialists in lean manufacturing, according to the following criteria: (a) relevance of each practice regarding the purpose of the scale; (b) clarity, coherence, and objectivity in the writing of the items; (c) use of words that are easy to understand; (d) verification and elimination of words with a double meaning; (e) verification of practices that were too long; (f) verification of the use of phrases that use excessively technical words or words that are rarely used in the professional environment; (g) verification and elimination of slang, colloquialisms, jargon, and abbreviations, as suggested by Johnson and Morgan (2016). The main changes made to the scale in this first step were in the name of some constructs and items to make them more specific. After this semantic validation by experts, we ended with 15 practices (see Table 5.1) and 66 items to measure employee involvement in lean manufacturing.

Table 5. 1 List of employee involvement practices

Practices	Definition	Reference
Guarantee that individual's behaviors follow companies' goals (P1)	The company and employees' goals must be strategically aligned when their behaviors correspond to their utilization strategy (Gagnon et al., 2008).	Brown and Reich (1989); Power and Sohal (1997); Baird and Lansbury (1998); Gagnon et al. (2008).
Continuous development of employee's leadership skills (P7)	The company should develop leadership skills (communication, listening, and feedback). This is important because a higher degree of trust in leadership results in proactive behaviors by frontline employees, encouraging them to use autonomy in their day-to-day tasks to identify and make systematic improvements in work processes (Anand et al., 2012).	Cheng (1991); Cheng and Musaphir (1993); McBain (2007); Evans and Redfern (2010); Anand et al. (2012); Godinho Filho et al. (2016); Lodgaard et al. (2016); Dellve et al. (2018); Soetara et al. (2018); Sisson (2019); Ahlstrand and Gautié (2022); Azalanzazllay et al. (2022).
Promotion of teamwork (P13)	Employee involvement implies that employees work in a group wherein each member has some level of input in the group's	Brown and Reich (1989); Golhar and Stamm (1991); Cheng (1991); Berg and Smith (1993); Cheng and Musaphir (1993); Karlsson and Åhlström (1996); McLachlin

Practices	Definition	Reference
	decisions, allowing them to be taken more systematically, integrated, and analytically (Grigg, 2010).	(1997); Power and Sohal (1997); Baird and Lansbury (1998); Clifford and Sohal (1998); Gupta et al. (2000); Power and Sohal (2000); Godard (2001); Richbell (2001); Birdi et al. (2008); Grigg (2010); Angelis and Fernandes (2012); Gollan et al. (2014); Stadnick and Antosz (2015); Rothstein (2016); Godinho Filho et al. (2016); De Vries and Van der Poll (2018); Roslin et al. (2019); Chen et al. (2020); Neirotti (2020); Signoretti (2020); Beraldin et al. (2022); Narayanan et al. (2022).
Multifuncional employee (job rotation) (P14)	Cross-training ensures that employees' experience is not limited to a single activity (Cheng, 1991).	Golhar and Stamm (1991); Cheng (1991); Cheng and Musaphir (1993); Berg and Smith (1993); Gupta et al. (2000); Power and Sohal (2000); Angelis and Fernandes (2012); Stadnick and Antosz (2015); Rothstein (2016); Soetara et al. (2018); Hernandez-Matias et al. (2020); Signoretti and Sacchetti (2020); Narayanan et al. (2022).
Drive suggestion programs (P11)	These programs create an environment conducive to employee involvement by encouraging reward-based improvement suggestions (Roslin et al., 2019).	Cheng (1991); Kim and Bae (2005); Angelis and Fernandes (2012); Jürgens and Krzywdzinski (2013); Liker and Ballé (2013); Gollan et al. (2014); Marksberry et al. (2014); Stadnick and Antosz (2015); Godinho Filho et al. (2016); Rothstein (2016); Roslin et al. (2019); Chopra and Fernando (2020); Kumar and Mathiyazhagan (2020); Neirotti (2020); Beraldin et al. (2022).
Education programs, training, and personal development (P6)	Companies should provide employees with programs that promote knowledge and self-development. These programs can be internal, performed by consultanciesand , and continuous training with external or postgraduate studies sponsored by the company (McLean et al., 2017; Stadnicka and Antosz, 2015).	Puvanasvaran et al. (2009); Assarlind (2015); Marin-Garcia and Bonavia (2015); Rothstein (2016); Stadnicka and Antosz (2015); Brkic and Tomic (2016); Shokri et al. (2016); Berlec et al. (2017); McLean et al. (2017); Boxall and Winterton (2018); Moica et al. (2019); Pereira et al. (2018); Rachman and Ratnayake (2019); Roslin et al. (2019); Sisson (2019); Chen et al. (2020); Hernandez-Matias et al. (2020); Jing et al. (2020); Kumar and Mathiyazhagan (2020); Signoretti (2020); Tran et al. (2020); Benkarim and Imbeau (2021); Van Assen (2021); Ahlstrand and Gautié (2022); Azalanzazllay et al. (2022); Boxall and Huo (2022); Qureshi et al. (2022).
Encouraging innovation and technologies (P15)	This refers to using information technology systems and active methodologies as a source of knowledge to inspire the involvement of employees with lean changes (Moica et al., 2019).	Stadnick and Antosz (2015); Berlec et al. (2017); Boxall and Winterton (2018); Pereira et al. (2018); Moica et al. (2019); Pereira and Liker (2021).
Intensive use of communication	Companies should use informal conversations and meetings to	Cheng (1991); Evans and Redfern (2010); Assarlind (2015); Vicente et al. (2015);

Practices	Definition	Reference
and feedback mechanism (P5)	involve employees. Day-to-day operations can be improved through informal discussions and meetings (Vicente et al., 2015).	Roslin et al. (2019); Hernandez-Matias et al. (2020); Neirotti (2020); Signoretti (2020); Tran et al. (2020); Ahlstrand and Gautié (2022); Klein et al. (Klein et al., 2022).
Top management providing resources (P2)	The company should make all the resources required to perform a task available. Resources refer to the job's physical, psychological, social, or utilization aspects (Huo and Boxall, 2018).	Clifford and Sohal (1998); Grigg (2010); McLean et al. (2017); Stelson et al. (2017); Huo and Boxall (2018); Dellve et al. (2018).
Middle management support (P4)	Management should support workers in performing improvement tasks (Bergquist and Westerberg, 2014).	McLachlin (1997); Daily and Huang (2001); Bergquist and Westerberg (2014); Bhattacharya (2015); Vicente et al. (2015); Soetara et al. (2018); Roslin et al. (2019); Dellve et al. (2018); Rachman and Ratnayake (2019); Hernandez-Matias et al. (2020); Signoretti (2020); Tran et al. (2020); González-Boubeta et al. (2021); Tezel et al. (2021); Boxall and Huo (2022); Klein et al. (Klein et al., 2022); Mathiyazhagan et al. (2022); Qureshi et al. (2022).
Promoting employee-friendly policies (P3)	The company should Promote employee-friendly policies such as an enabling environment for employees who want to participate and are highly involved in lean-centered activities through interpersonal relationships, improved quality of life at work, and balance between work and personal life (Roslin et al., 2019).	Godard (2001); Ahmad et al. (2003); Boxall and Winterton (2018); Beraldin et al. (2019); Roslin et al. (2019); Malik and Abdallah (2020); Yuik et al. (2020); Benkarim and Imbeau (2021); Boxall and Huo (2022).
Empowerment (job rotation) (P12)	Companies should empower employees to perform and operate correctly because liberty allows them to use creative decision-making and managing objectives to improve processes (Roslin et al., 2019).	Brown and Reich (1989); Cheng (1991); Berg and Smith (1993); McLachlin (1997); Power and Sohal (1997); Clifford and Sohal (1998); Power and Sohal (2000); Godard (2001); Daily and Huang (2001); Birdi et al. (2008); Evans and Redfern (2010); Richardson et al. (2010); Wickramasinghe and Wickramasinghe (2011); Anand et al. (2012); Angelis and Fernandes (2012); Bergquist and Westerberg (2014); Marin-Garcia and Bonavia (2015); Stadnick and Antosz (2015); Boxall and Winterton (2018); Roslin et al. (2019); Van Assen and De Mast (2019); Rupasinghe and Wijethilake (2020); Signoretti and Sacchetti (2020); Ahlstrand and Gautié (2022); De Koeijer et al. (De Koeijer et al., 2022); Narayanan et al. (2022).
Providing career advancement opportunities to	Provide career opportunities to employees towards their future	Bhattacharya (2015).

Practices	Definition	Reference
employees (P10)	growth in the utilization based on their merits and performances (Bhattacharya, 2015).	
Use of Kaizen events (P8)	Kaizen events are used to solve problems regularly and increase workers' participation towards making improvements. Impressed by the outcome, the employees strive to keep the event alive through the daily Kaizen methodology. Corporate culture thrives, increasing employee participation (Vo et al., 2019).	Wickramasinghe and Wickramasinghe (2017); Rachman and Ratnayake (2019); Vo et al. (2019); Kumar and Mathiyazhagan (2020); Wickramasinghe and Chathurani (2020).
Use of reward-based incentives (P9)	Programs implemented to reward workers, in addition to fixed remuneration (salary and annual raises), with variable pay that depends on performance, increasing collective efforts, professionalism, and flexibility (Wickramasinghe and Wickramasinghe, 2016). Employee involvement can be improved by recognizing achievements and rewarding innovation (Soetara et al., 2018).	Evans and Redfern (2010); Ganster et al. (2011); Haleem et al. (2012); Gollan et al. (2014); Martinez-Jurado et al. (2014); Assarlind (2015); Marin-Garcia and Bonavia (2015); Stadnick and Antosz (2015); Brkic and Tomic (2016); Rothstein (2016); Wickramasinghe and Wickramasinghe (2016); McLean et al. (2017); Boxall and Winterton (2018); Soetara et al. (2018).

Source: elaborated by the author

5.3.2 Step 2 – Establishing the Constructs' and Items' Reliability and Validity – Sorting Item

The second step establishes the constructs' and items' reliability and validity. Four rounds were carried out until reaching the stipulated level of agreement Four rounds of classification of the constructs and items were carried out with judges from the area of operations management. The criterion used for selecting judges was that they had prior knowledge of lean manufacturing. This was an iterative process in which judges identified the practices and items based on the definitions provided. According to these definitions, the judges associated each assertion with the practice that represented it the most. For each round, judges (postgraduate students and teachers) were instructed to carefully read the definitions of each employee involvement practice and list each item (COSTA et al., 2021; DEVELLIS, 2022; MACKENZIE et al., 2011). Four rounds were conducted with convenience samples of 18, 18, 18, and 18 judges (totaling 72). For each of the four rounds, the questionnaire was sent to a new group of judges, with the possibility of repeating judges in each round.

Each round was analysed using three inter-rater reliability estimators. First, the inter-judge agreement percentage refers to the agreement ratio between all pairs of judges. This was calculated by the proportion of item classification and the total number of judgments (HANSON, 2022). The agreement percentage is the agreement ratio between pairs of judges. This estimator was used in conjunction with other reliability measures. Second, Cohen's kappa determines to what extent the frequency of exact agreements between judges exceeds what could be expected by chance (DEVELLIS, 2022; HANSON, 2022). This is an estimator that assesses the adequacy between raters. When the index is between 0.40 and 0.60, it is considered realistic, while kappa between 0.20 and 0.40 would be only acceptable (HANSON, 2022; YAN; GONG, 2022). Finally, Perreault and Leigh's Ir indicates the probability that two judges both independently make a reliable judgment. This estimator indicates that values less than 0.6 or 0.5 need corrections (ROSSITER, 2011).

In addition to ensuring reliability, we assessed substantive face validity (MENOR; ROTH, 2007), which indicates the extent to which all scales would be judged valid (DEVELLIS, 2022). To this end, we used two substantive validity estimators. First, we used the proportion of substantive agreement (PSA), which indicates the proportion of raters who assign an item to the construct. This indicator ranges from 0 to 1; the closer to 1, the greater the validity. Second, we used the coefficient of substantive validity (CSV), which measures how judges relate an item to a construct rather than any other construct. The CSV ranges from –1 to 1, with more positive results indicating greater substantive validity (DEVELLIS, 2022).

The overall placement ratio (OPR) was also used to assess the number of items placed correctly in a construct. The OPR provides evidence of the classification of the items, and it is useful to detect measurement errors. This indicator guides decisions concerning keeping, revising, or deleting items. Measurements with results greater than 70% indicate high reliability (BANDALOS, 2018).

After each round, the above estimators improved the multi-item scale to measure employee involvement in lean manufacturing. For example, several items presenting low validity estimators, no consensus between judges, and/or redundancy were eliminated. After the fourth round, the reliability and validity estimators were considered acceptable. We obtained Cohen's κ larger than 0.5, the average of Perreault and Leigh's Ir was greater than 0.8, and the validity estimators (PSA and CSV) were greater than 0.8 and 0.68, respectively. Finally, after the necessary analysis and modifications, an OPR greater than 0.70 was achieved (see Tables 5.2 and 5.3).

Table 5.2 - Comparison of interrater reliability and validity estimators

Reliability and Validity Estimators	First Round [a]	Second Round	Third Round	Fourth Round
Interjudge agreement percentage (%)	46 – 69	68 – 73	68 – 75	62 - 70
Cohen's k	0,13 – 0,45	0,51 – 0,56	0,55-0,58	0,55 – 0,64
Perreault and Leigh's Ir	0,60 – 0,80	0,78 – 0,82	0,79 – 0,84	0,80 – 0,86
Proportion of substantive validity (p_{sa})	0,70	0,79	0,80	0,82
Coefficient of substantive validity (c_{sv})	0,30	0,44	0,52	0,68
Overall Placement Ratio (OPR)	68%	76%	83%	83%

[a] Independent samples of n judges per sorting round: round 1, n = 18; round 2, n = 18; round 3, n = 18; round 4, n = 18

Source: Elaborated by the author

The main changes made to the scale in this second step were in the name of some items to make them more specific and the deletion and merging of practices. The practices that had a name change were "encourage innovation and technologies", "making job resources available", "management support", and "aligning employee's goals with the company's goals". The practice "promote employee-friendly policies practice" was excluded. As a result of this exclusion four items were removed. The practices "intensive use of communication" and "feedback mechanisms" were often confused. Therefore, we combined these practices as "intensive use of communication and feedback mechanisms". This merge eliminated six items. All the other practices were maintained. However, two items were excluded over the rounds of sorting items because they were biased in writing with other items.

Table 5.3 - Overall Placement Ratios for each practice

Practice	First Round	Second Round	Third Round	Fourth Round
Guarantee that individual's behaviors follow companies' goals (P1)	51%	77%	80%	82%
Top management providing resources (P2)	70%	75%	75%	77%
Promote employee-friendly policies (P3)	66%	66%	68%	71%
Middle management support (P4)	70%	72%	75%	77%
Intensive use of communication and feedback mechanisms (P5)	70%	85%	92%	96%

Practice	First Round	Second Round	Third Round	Fourth Round
Education programs, training, and personal development (P6)	70%	78%	78%	94%
Continuous development of employee’s leadership skills (P7)	79%	82%	83%	85%
Use of kaizen events (P8)	60%	80%	78%	82%
Use of Reward-based incentives (P9)	70%	76%	76%	77%
Provide career advancement opportunities for employees (P10)	77%	70%	84%	92%
Drive suggestion programs (P11)	70%	88%	77%	79%
Empowerment (job autonomy) (P12)	96%	96%	91%	91%
Promotion of teamwork (P13)	31%	47%	76%	79%
Multifunctional employee (job rotation) (P14)	73%	79%	80%	85%
Encourage innovation and technologies (P15)	69%	72%	74%	80%
Average	68%	76%	78%	82%

Source: elaborated by the author

Refinements were made to other constructs and assertions to make them more understandable (LUSE; BURKMAN, 2022; MACKENZIE et al., 2011). These changes were made based on the results of each round. The main goal is to make the assertions more apparent to the Q-Sort judges. In this sense, the results of each round will improve the constructs and measures. Thus, 14 practices and 54 items were considered for the scale to measure employee involvement in lean manufacturing.

5.3.3 Step 3 – Ensuring Convergent and Discriminant Validity (Pre-test)

After the development of measures and model specification, we collect data to conduct a pre-test to preserve scale evaluation and refinement (LAMBERT; NEWMAN, 2022; MACKENZIE et al. 2011). The pre-test was applied with operators from three manufacturing companies implementing lean manufacturing. In this study, the pre-test was applied to people using non-probability sampling, given the exploratory nature of the survey (FORZA, 2002). The SurveyMonkey platform was used to structure the items in a questionnaire format to assess the operators. The 14 practices were administered to a sample of 103 operators through the SurveyMonkey platform.

The informed consent form briefly described the researchers and the research objectives. In this document, we guaranteed the confidentiality of the participants and the information they provided.

The 103 responses received were evaluated to identify suspicious response patterns, such as the occurrence of straight lines, missing data, and multivariate outliers. We calculated the Z-score values to identify the multivariate outliers (FAULKENBERRY, 2022). After screening the data, nine multivariate outliers were found (*Z*-score > 2.58) and excluded, leaving 94 complete responses.

The profile of the 94 respondents can be defined as follows. Regarding education, 56% have completed higher education, 41% have completed high school, and 3% did not want to answer. As for time at the company, 4% have been with the company for less than one year, 16% have been with the company for between 1 and 4 years, 22% are between 4 and 7 years, 23% are between 7 and 10 years, 34% more than ten years and 1% did not want to answer.

The pre-test was analysed using exploratory factor analysis (EFA) to evaluate the convergent and discriminant validity (third step) to examine the scale's psychometric properties. This statistical technique can examine the underlying patterns or relationships for many items and determine whether the information can be condensed or summarized into smaller factors or components (FIELD, 2018; DENIS, 2019; HAIR et al., 2019). The R software and the psy, psych, MASS and mirt packages were used to apply the EFA, and several core metrics were evaluated such as the Kaiser–Meyer–Olkin (KMO) test and Bartlett’s test of sphericity.

Regarding the interpretation of the KMO test, values lower than 0.50 are unacceptable, while values between 0.60 and 0.90 are considered excellent (FIELD, 2018; Hair *et al.*, 2019; YAN; GONG, 2022). Our KMO test for the items measuring employee involvement in lean manufacturing showed a value of 0.84 with a χ^2 value 611.92. These results conclude that the KMO test satisfies the rule of thumb. Furthermore, Bartlett’s test of sphericity was examined. This test identifies to what extent the covariance matrix is similar to an identity matrix to show that they do not correlate with each other (FIELD, 2018). Bartlett’s test values with significance levels less than 0.01 indicate that the matrix is uncorrelated and favourable (HAIR *et al.*, 2019). We found Bartlett’s test showed a *p*-value equal to $2.2\text{x}10^{-16} < 0.01$. It is noteworthy that all the indices of the anti-image matrix [measures of sampling adequacy (MSA)] are more significant than 0.70, which confirms the satisfactory execution of the EFA method (SHUCK et al., 2017).

Hair et al. (2019) affirmed that EFA analyses the correlations between many variables, resulting in factors (common latent dimensions). Several methods can be used for factor extraction. In this paper, we use principal axis factoring (PAF) (WATTS et al., 2020). This method presents the factors that can explain most of the variance of the sample, making each construct more coherent (NGUYEN et al., 2019). We simplified the factor solution using the Promax oblique rotation method and eigenvalues greater than 1 (NGUYEN et al., 2019; WATTS et al., 2020). The rotation consists of building a matrix of the items, and this matrix is rotated until an optimal relationship between the data is found (WATTS et al., 2020). Such a rotation method allows the assumptions of independence between the factors to be removed, simplifying interpretation (DEDEOGLU et al., 2020; NGUYEN et al., 2019).

The communalities (h2) are the amount of variance (correlations) of each variable explained by the factors (FIELD, 2018). The higher the communality, the better the explanation power of that factor. The literature indicates a minimum value of 0.5 for the communality to be considered satisfactory (DENIS, 2019; HAIR *et al*., 2019). For reasons of conservatism, it was decided to keep items close to 0.5 at this research stage. Nevertheless, it is important to highlight that caution is advised when removing items during this stage of Exploratory Factor Analysis (EFA), as suggested in the literature. Therefore, despite the possibility of inappropriate values in the factor extraction phase, it is crucial to take into account the significance of the item in terms of its content (NETEMEYER; BEARDEN; SHARMA, 2003). Items like "P13.2" (I often feel satisfied with achievements achieved by the work team of which I am part) and "P15.3" (I agree that my company invests in new technologies, such as comprehensive modelling tools and specialty software, in lean efforts) had communalities equal to 0.29. They were also kept in a conservative perspective because this item is essential for employee involvement in lean manufacturing (Table 5.4).

Table 5.4 Communalities regarding the distribution of loads in the extracted factors for employee involvement in lean manufacturing.

Item	Code	Factor 1	Factor 2	h2
I consider that my individual goals are aligned with the company's objectives.	P1.1	0,550	0,330	0,570
I consider that my individual goals are aligned with the objectives of the following task/activity/process (internal customer view)	P1.2	0,440	0,400	0,500
I frequently participate in meetings to align the objectives of my sector, area of expertise, or process.	P1.3	0,710		0,560
I agree/I am aware of the results that my managers define for my work	P1.4		0,650	0,470
I can often achieve the objectives my managers set for my work.	P1.5		0,750	0,470

Item	Code	Factor 1	Factor 2	h2
I often advance in my career based on merit and performance	P10.1	0,500	0,320	0,490
I often have excellent opportunities to improve my career.	P10.2	0,500	0,400	0,580
I am often guided by my company to develop skills that help me improve and succeed in my career.	P10.3		0,760	0,490
I frequently suggest ideas for improvement suggestion programs	P11.1	0,360	0,400	0,410
I frequently make suggestions for product and process improvements	P11.2	0,530		0,380
I often make suggestions for improving the conditions of the work environment	P11.3		0,720	0,440
I often feel empowered or empowered to make decisions about my work	P12.1	0,600		0,520
I often have the autonomy to actively contribute to making decisions about my area, process or department	P12.2	0,750		0,670
I often have autonomy to use my skills and abilities to perform and/or improve my work.	P12.3	0,310	0,580	0,580
My manager often delegates powers to me to make decisions about my work	P12.4		0,630	0,400
I am often tasked by my manager with making decisions about the area or process in which I work.	P12.5	0,750		0,620
I often get involved in decision-making work teams	P13.1	0,780		0,640
I often feel satisfied with the achievements achieved by the work team I am part of.	P13.2		0,560	0,290
I often contribute to the group decision-making process	P13.3	0,800		0,640
I am often trained in more than one area of work	P14.1*	0,910		0,690
I often receive cross-training, which ensures that I am not an expert in just one activity.	P14.2	0,790		0,660
I often participate in cross-training to develop multiple skills	P14.3*	0,910		0,710
I agree that my company uses information technology systems as a source of knowledge to inspire and engage me in lean change.	P15.1	0,850		0,590
I am often involved in activities that use active methodologies as a source of knowledge to inspire me to engage in lean change.	P15.2	0,330	0,520	0,520
I agree that my company invests in new technologies, such as comprehensive modeling tools and specialty software, in lean efforts.	P15.3	0,590		0,290
I frequently use collaborative technology with tools and systems designed and made available by my company to facilitate group work, both in the office and remotely	P15.4*	0,950	-0,450	0,750
I often have enough time for myself and my team to carry out our lean responsibilities.	P2.1		0,620	0,480
I often have access to a dedicated meeting room and dedicated spaces for teams to post communications.	P2.2		0,700	0,410
I agree that my company seeks to use top talent in lean efforts. In addition, participation is always encouraged but not required.	P2.3		0,750	0,500
I often have technology resources provided by my company to use in lean implementation/efforts	P2.4*	1,010	-0,450	0,830

Item	Code	Factor 1	Factor 2	h2
I often have support from my managers in carrying out improvement tasks	P4.1		0,790	0,610
I agree that in my company, senior managers allocate financial and non-financial resources (such as time) to lean efforts.	P4.2	0,600		0,490
I can often rely on my senior managers, who are always available to assist us when we have a problem.	P4.3	0,620		0,590
I can often communicate with anyone in the company, whether they are from another area, process, or department.	P5.1	0,500		0,390
I often participate in informal conversations with my managers about issues and improvement initiatives.	P5.2	0,880		0,700
I frequently communicate formally (meetings, and emails) with my managers about issues and improvement initiatives.	P5.3	0,750		0,610
I often participate in informal conversations with my co-workers about issues and improvement initiatives.	P5.4		0,410	0,360
I frequently communicate formally (meetings and emails) with my co-workers about issues and improvement initiatives.	P5.5	0,550		0,530
I often participate in training programs that provide me with knowledge and self-development	P6.1		0,640	0,440
I often participate in technical training in lean production	P6.2		0,850	0,610
I often attend training to develop teamwork skills (e.g., communication and interpersonal skills)	P6.3		0,730	0,480
I often participate in training with adequate quality	P6.4		0,850	0,630
I am often encouraged to develop leadership skills by my company, which encourages me to use my autonomy on a day-to-day basis.	P7.1		0,790	0,660
I agree that my company is concerned with continuously monitoring employee leadership skills and takes action to improve these skills.	P7.2		0,580	0,390
I often rely on our leaders to challenge existing ways of doing work and share knowledge about different ways of doing work.	P7.3		0,680	0,600
I often participate in kaizen events.	P8.1		0,710	0,430
I often voluntarily participate in continuous improvement (kaizen) events	P8.2	-0,520	0,810	0,570
I am often encouraged to participate in improvement events to solve complex problems.	P8.3	0,430	0,340	0,430
I am often motivated/enjoyed to participate in kaizen events	P8.4	-0,430	0,700	0,420
I often draw on lessons from previous kaizen events to solve new problems.	P8.5		0,590	0,420
I frequently engage in product and process improvement efforts	P8.6	0,400	0,430	0,490
I often receive, in addition to fixed compensation (salary and annual raises), rewards with variable compensation that depends on performance, collective effort, professionalism, and flexibility.	P9.1	0,730		0,490
I frequently receive recognition for my achievements and rewards for innovative ideas.	P9.2*	0,960		0,780

Item	Code	Factor 1	Factor 2	h2
I am often rewarded for group achievements	P9.3	0,690		0,600
Percentage of variance explained.		29.0		25.0
Cumulative explained variance percentage.		29.0		54.0

Note(s): * Item loading above 0.9; ** item showed cross-loading; *** item presented a load lower than the cut-off value.

Hair et al. (2019) pointed out that the limit of the factorial load to be adopted depends on the sample size, and the larger the sample size, the lower the factorial load. Thus, the candidate items excluded were those with loadings lower than 0.50 (cut-off), cross-loadings higher than 0.50 on the same factor, and communalities lower than 0.50 (WATTS et al., 2020). For reasons of conservatism, we kept the factor loadings close to 0.3. In the present study, the analysis resulted in a diagonal matrix greater than 0.5, ensuring the adequacy of the sample.

The explained variance (sum of the squares of the explained variance values) describes how reliable the model that describes the observable phenomenon is (FURR, 2017). Employee involvement in lean manufacturing explained the total variance of 54.00%, with the respective divisions of 29.00% (Factor 1) and 25.00% (Factor 2). Table 5.3 shows the distribution of the waves in each factor.

The candidate items excluded were those with loadings lower than 0.30 (cut-off) and cross-loadings higher than 0.50 on the same factor. However, it is worth noting that the literature recommends caution in eliminating items in this phase of the EFA. Thus, even if the loadings represent inappropriate values in the factor extraction phase, it is vital to consider the item's significance in terms of the content (NETEMEYER; BEARDEN; SHARMA, 2003).

Thus, the scale now comprises 14 constructs and 54 items that measure employee involvement in lean manufacturing. Given the rigor in the validation steps suggested by DeVellis (2022), Lambert and Newman (2022), and MacKenzie et al. (2011), we opted for a more conservative posture regarding eliminating an item from the scale in this purification step. We emphasize that we adopted a more rigid stance in the scale's reliability and validity assessment stage described in the next section.

5.3.4. Step 4 – Ensuring Convergent and Discriminant Validity (large survey)

A new survey was conducted with manufacturing industry operators distributed throughout Brazil's northern and southeast regions through non-probability sampling. As this is an exploratory study, this type of sampling is recommended (FORZA, 2002). We used the SurveyMonkey data collection platform, as in the pre-test phase. According to Dillman et al. (2014), online questionnaires have several benefits, such as reaching distant respondents, reducing research bias, increasing the survey's response rate, and being more convenient for the respondents. The research instrument and the processes of planning, conducting, and administering the survey followed the same procedures described in the pre-test phase.

The survey questionnaire resulted in 206 responses. We identified 30 cases of multivariate outliers based on the *Z*-score values (FAULKENBERRY, 2022). Thus, we obtained a final sample of 176 respondents. The parametric t-test of the Byers groups and the non-parametric Mann-Whitney tests were performed, resulting in a p-value greater than 0.05 for both, showing that the sample did not skew.

Regarding education, 57% have completed higher education, 36% have completed high school, and 7% did not want to answer. As for time at the company, 6% have been with the company for less than one year, 18% have been with the company for between 1 and 4 years, 25% are between 4 and 7 years, 17% are between 7 and 10 years, 30% more than ten years and 4% did not want to answer.

To analyze the reliability and validity of the scale, a Partial Least Squares (PLS) technique was used through SmartPLS 3 software (RINGLE et al., 2015). The guidelines proposed by Hair et al. (2018) were followed for the execution of the CFA with PLS-SEM, an environment for modeling structural equations. Merza et al. (2018) showed that PLS has been used recently for scale development. Lee et al. (2011) argue that the PLS allows the simultaneous analysis of the measurement and structural model, allowing researchers to adopt more sophisticated models of surveys that contain moderation and mediation relationships.

The scale was preconceived, considering a solid correlation between the CP dimensions and subdimensions. So, the CFA measurement of the model considered the latent variables to be reflexive. Assuming the reflexive aspect of the constructs, the recommended procedure by Hair et al. (2014) was adopted to validate constructions.

Composite Reliability (CR) was used as an indicator to evaluate the internal consistency between items in each construct. The internal consistency between the items of each construct is confirmed when CR is greater than 0.7. Convergent validity is confirmed when the Average Variance Extracted (AVE) is superior to 0.5. AVE value is related to the load of each item of the construct, which should be above or equal to 0.7 so that the latent variable (construct) explains a substantial part of the variance of each indicator. Loads between 0.40 and 0.69 can be used to remove the model. When a low load indicator is excluded, there is an increase in CR and AVE (HAIR et al., 2014). The discriminant validity between the constructs was assessed by the analysis of cross-loadings and by the Fornell-Larcker and HTMT criterion, and the results of the evaluation of the discriminant validity were presented. In the criteria of cross-load (Table 5.5), the items presented show a higher load in their corresponding constructor than the other adjacent constructors.

Table 5.5 cross-loadings

Items	P1	P10	P11	P12	P13	P14	P15	P2	P4	P5	P6	P7	P8	P9
P1.1	**0,825**	0,419	0,378	0,472	0,536	0,483	0,473	0,439	0,470	0,538	0,323	0,470	0,441	0,419
P1.2	**0,839**	0,371	0,431	0,483	0,424	0,405	0,366	0,396	0,476	0,454	0,331	0,425	0,465	0,365
P1.3	**0,731**	0,274	0,460	0,554	0,462	0,525	0,354	0,493	0,422	0,541	0,237	0,251	0,426	0,456
P1.4	**0,663**	0,423	0,330	0,354	0,332	0,274	0,156	0,275	0,361	0,335	0,440	0,444	0,346	0,204
P10.1	0,379	**0,808**	0,292	0,476	0,421	0,444	0,432	0,449	0,438	0,533	0,333	0,390	0,318	0,426
P10.2	0,391	**0,833**	0,283	0,520	0,436	0,392	0,481	0,509	0,391	0,440	0,352	0,436	0,423	0,495
P10.3	0,299	**0,568**	0,119	0,241	0,201	0,149	0,194	0,117	0,294	0,174	0,431	0,531	0,216	0,211
P11.1	0,487	0,352	**0,840**	0,406	0,476	0,398	0,372	0,436	0,372	0,433	0,255	0,348	0,495	0,442
P11.2	0,429	0,223	**0,835**	0,445	0,491	0,448	0,330	0,324	0,374	0,534	0,283	0,201	0,462	0,373
P11.3	0,262	0,155	**0,644**	0,188	0,308	0,086	0,056	0,077	0,273	0,214	0,384	0,322	0,318	0,130
P12.1	0,495	0,397	0,356	**0,721**	0,451	0,529	0,434	0,455	0,359	0,525	0,230	0,374	0,323	0,534
P12.2	0,541	0,448	0,403	**0,826**	0,494	0,589	0,476	0,476	0,562	0,604	0,276	0,378	0,503	0,541
P12.3	0,459	0,465	0,386	**0,736**	0,437	0,350	0,359	0,331	0,488	0,436	0,432	0,560	0,537	0,404
P12.4	0,218	0,342	0,210	**0,553**	0,227	0,159	0,107	0,234	0,275	0,189	0,383	0,340	0,385	0,266
P12.5	0,438	0,436	0,316	**0,761**	0,418	0,591	0,476	0,555	0,478	0,570	0,271	0,312	0,450	0,513
P13.1	0,452	0,398	0,485	0,519	**0,871**	0,472	0,460	0,468	0,329	0,564	0,199	0,306	0,532	0,435
P13.2	0,353	0,388	0,284	0,280	**0,484**	0,175	0,200	0,216	0,305	0,235	0,355	0,369	0,293	0,122
P13.3	0,510	0,369	0,479	0,476	**0,867**	0,462	0,471	0,530	0,283	0,536	0,163	0,240	0,496	0,497
P14.1	0,362	0,364	0,332	0,430	0,408	**0,773**	0,480	0,517	0,288	0,503	0,129	0,198	0,236	0,582
P14.2	0,547	0,488	0,419	0,580	0,460	**0,862**	0,546	0,542	0,628	0,558	0,282	0,384	0,444	0,579
P14.3	0,457	0,290	0,329	0,566	0,396	**0,837**	0,490	0,489	0,493	0,518	0,120	0,267	0,377	0,594
P15.1	0,374	0,376	0,221	0,404	0,390	0,529	**0,847**	0,567	0,391	0,454	0,119	0,249	0,319	0,595
P15.2	0,380	0,415	0,326	0,424	0,331	0,284	**0,675**	0,326	0,478	0,394	0,493	0,487	0,474	0,396
P15.3	0,206	0,322	0,247	0,233	0,302	0,389	**0,674**	0,385	0,243	0,226	0,111	0,154	0,163	0,426
P15.4	0,361	0,427	0,283	0,498	0,501	0,612	**0,781**	0,631	0,355	0,428	0,049	0,161	0,292	0,636
P2.1	0,418	0,412	0,336	0,432	0,315	0,245	0,320	**0,711**	0,303	0,271	0,453	0,416	0,407	0,382
P2.4	0,392	0,385	0,272	0,452	0,515	0,671	0,642	**0,805**	0,351	0,567	0,031	0,140	0,293	0,578
P4.1	0,342	0,465	0,338	0,400	0,226	0,227	0,220	0,228	**0,638**	0,271	0,516	0,540	0,417	0,189
P4.2	0,460	0,255	0,324	0,432	0,340	0,513	0,424	0,320	**0,748**	0,472	0,272	0,406	0,453	0,406
P4.3	0,429	0,409	0,310	0,500	0,285	0,509	0,434	0,385	**0,793**	0,427	0,203	0,337	0,374	0,410

Items	P1	P10	P11	P12	P13	P14	P15	P2	P4	P5	P6	P7	P8	P9
P5.1	0,355	0,382	0,325	0,367	0,418	0,367	0,435	0,429	0,328	**0,678**	0,231	0,312	0,325	0,388
P5.2	0,506	0,455	0,414	0,568	0,507	0,617	0,526	0,540	0,451	**0,834**	0,143	0,246	0,413	0,605
P5.3	0,533	0,402	0,432	0,540	0,507	0,555	0,399	0,434	0,448	**0,840**	0,274	0,314	0,458	0,471
P5.4	0,382	0,320	0,403	0,397	0,349	0,297	0,182	0,259	0,317	**0,567**	0,300	0,314	0,315	0,220
P5.5	0,494	0,452	0,418	0,581	0,472	0,480	0,343	0,414	0,451	**0,765**	0,374	0,384	0,426	0,432
P6.1	0,404	0,384	0,356	0,375	0,276	0,234	0,302	0,332	0,347	0,346	**0,813**	0,480	0,372	0,347
P6.2	0,314	0,284	0,247	0,253	0,218	0,030	0,112	0,189	0,274	0,154	**0,781**	0,425	0,436	0,097
P6.3	0,291	0,379	0,299	0,333	0,201	0,218	0,213	0,170	0,329	0,229	**0,714**	0,379	0,355	0,186
P6.4	0,296	0,421	0,234	0,340	0,185	0,177	0,161	0,199	0,400	0,322	**0,814**	0,474	0,402	0,152
P7.1	0,403	0,552	0,304	0,460	0,305	0,254	0,290	0,275	0,410	0,306	0,519	**0,795**	0,419	0,279
P7.2	0,390	0,418	0,258	0,317	0,270	0,271	0,273	0,260	0,453	0,309	0,374	**0,729**	0,328	0,242
P7.3	0,379	0,338	0,256	0,440	0,289	0,279	0,258	0,262	0,454	0,337	0,391	**0,756**	0,420	0,325
P8.3	0,389	0,438	0,311	0,524	0,373	0,395	0,401	0,384	0,463	0,388	0,400	0,381	**0,764**	0,351
P8.5	0,324	0,242	0,423	0,388	0,426	0,214	0,241	0,223	0,385	0,246	0,344	0,375	**0,708**	0,279
P8.6	0,486	0,272	0,502	0,409	0,509	0,330	0,292	0,370	0,392	0,499	0,345	0,377	**0,726**	0,250
P9.1	0,338	0,457	0,293	0,511	0,386	0,541	0,561	0,530	0,380	0,453	0,179	0,321	0,315	**0,837**
P9.2	0,424	0,405	0,378	0,556	0,448	0,671	0,622	0,588	0,395	0,529	0,117	0,220	0,310	**0,846**
P9.3	0,458	0,486	0,433	0,557	0,425	0,585	0,588	0,515	0,420	0,506	0,367	0,402	0,393	**0,863**

Source: elaborated by the author

In the Fornell-Larcker criterion, discriminant validity was evidenced for the first-order constructs, in which the square root of the AVE located on the diagonal of the table of values must be greater than the correlations with the horizontal and vertical constructs (HAIR et al., 2021). Complementary, we obtained values for the HTMT ratios less than the 0.85 thresholds based on the multitrait-multimethod (MTMM) matrix (see Table 5.6)

Table 5.6 Fornell-Larcker and HTMT criterion

	P1	P10	P11	P12	P13	P14	P15	P2	P4	P5	P6	P7	P8	P9
P1	**0,768**	0,719*	0,697*	0,769*	0,815*	0,710*	0,573*	0,834*	0,823*	0,781*	0,553*	0,745*	0,819*	0,597*
P10	0,479	**0,746**	0,519*	0,818*	0,823*	0,644*	0,740*	0,803*	0,839*	0,746*	0,720*	0,838*	0,717*	0,727*
P11	0,523	0,327	**0,778**	0,620*	0,842*	0,545*	0,486*	0,842*	0,713*	0,695*	0,532*	0,565*	0,839*	0,538*
P12	0,612	0,577	0,470	**0,725**	0,811*	0,791*	0,663*	0,846*	0,815*	0,816*	0,558*	0,770*	0,809*	0,791*
P13	0,579	0,494	0,559	0,574	**0,762**	0,721*	0,741*	0,822*	0,700*	0,842*	0,455*	0,653*	0,815*	0,668*
P14	0,560	0,468	0,440	0,642	0,512	**0,825**	0,809*	0,831*	0,813*	0,804*	0,277*	0,493*	0,631*	0,809*
P15	0,454	0,521	0,361	0,538	0,518	0,614	**0,748**	0,804*	0,755*	0,651*	0,345*	0,515*	0,635*	0,823*
P2	0,530	0,521	0,396	0,581	0,556	0,625	0,649	**0,759**	0,807*	0,838*	0,724*	0,836*	0,839*	0,838*
P4	0,567	0,507	0,442	0,610	0,393	0,584	0,502	0,432	**0,729**	0,804*	0,681*	0,842*	0,805*	0,686*
P5	0,617	0,544	0,534	0,669	0,612	0,639	0,518	0,567	0,543	**0,744**	0,439*	0,601*	0,763*	0,715*
P6	0,423	0,475	0,369	0,423	0,285	0,222	0,263	0,294	0,436	0,348	**0,781**	0,791*	0,742*	0,318*
P7	0,513	0,576	0,359	0,537	0,379	0,352	0,360	0,349	0,575	0,417	0,566	**0,760**	0,841*	0,516*
P8	0,550	0,440	0,558	0,605	0,593	0,436	0,432	0,453	0,566	0,525	0,496	0,514	**0,733**	0,585*
P9	0,482	0,530	0,437	0,639	0,495	0,706	0,696	0,641	0,470	0,586	0,265	0,372	0,401	**0,849**

Note(s): Diagonal and bold elements and below the diagonal are values of Fornell-Lacker. The values above the diagonal show the HTMT values.

Many iterations were performed in the evaluation process of the measurement model until the achievement of reliability and validity was satisfactory. In each iteration, variables were excluded to increase the reliability and validity of the constructs. Items P1.5, P2.2, P2.3, P8.1, P8.2, and P8.3 had low factor loading values and were excluded. After exclusions, AVE values in all practices were more significant than 0.500, ensuring convergent validity. To assess the significance of the items ($p < 0.01$) with load values between 0.482 and 0.87. Bootstrapping was performed with 5000 subsamples (STREUKENS; LEROI-WERELDS, 2016). Collinearity was not observed as the variance inflation factor (VIF) values were less than 5 (HAIR et al., 2021). The convergent validity and reliability of the constructs were confirmed once the obtained values of CR > 0.7 and AVE >0.5 were reached, significantly exceeding the minimum necessary values (see Table 5.7).

Table 5.7 - Outer loadings and VIF values

	Outer loading	sd	t-test	p-value	CR	AVE	VIF
P2					0,797	0,663	
P2.1	0,711	0,060	11,805	0,000			2,222
P2.4	0,805	0,038	20,952	0,000			1,025
P4					0,772	0,532	
P4.1	0,638	0,067	9,485	0,000			1,109
P4.2	0,748	0,050	15,113	0,000			1,188
P4.3	0,793	0,041	19,373	0,000			1,262
P5					0,859	0,553	
P5.1	0,678	0,040	17,063	0,000			1,378
P5.2	0,834	0,023	35,558	0,000			2,012
P5.3	0,840	0,028	30,161	0,000			2,245
P5.4	0,567	0,063	8,940	0,000			1,228
P5.5	0,765	0,037	20,851	0,000			1,695
P6					0,862	0,611	
P6.1	0,813	0,031	26,237	0,000			1,618
P6.2	0,781	0,044	17,875	0,000			1,722
P6.3	0,714	0,044	16,036	0,000			1,372
P6.4	0,814	0,035	23,079	0,000			1,725
P15					0,833	0,557	
P15.1	0,847	0,026	32,731	0,000			1,886
P15.2	0,675	0,042	16,074	0,000			1,23
P15.3	0,674	0,056	12,060	0,000			1,444
P15.4	0,781	0,032	24,174	0,000			1,496
P7					0,804	0,578	
P7.1	0,795	0,034	23,479	0,000			1,293
P7.2	0,729	0,060	12,220	0,000			1,222
P7.3	0,756	0,049	15,370	0,000			1,238

	Outer loading	sd	t-test	p-value	CR	AVE	VIF
P9					0,885	0,721	
P9.1	0,837	0,025	34,073	0,000			1,744
P9.2	0,846	0,026	32,132	0,000			1,721
P9.3	0,863	0,022	39,061	0,000			1,778
P10					0,788	0,558	
P10.1	0,808	0,033	24,818	0,000			1,288
P10.2	0,833	0,027	30,650	0,000			1,334
P10.3	0,568	0,069	8,257	0,000			1,114
P11					0,821	0,608	
P11.1	0,840	0,026	32,271	0,000			1,39
P11.2	0,835	0,030	27,830	0,000			1,408
P11.3	0,644	0,063	10,178	0,000			1,238
P12					0,846	0,526	
P12.1	0,721	0,044	16,279	0,000			1,489
P12.2	0,826	0,028	29,671	0,000			1,991
P12.3	0,736	0,043	17,073	0,000			1,663
P12.4	0,553	0,081	6,820	0,000			1,403
P12.5	0,761	0,038	19,896	0,000			1,688
P13					0,798	0,58	
P13.1	0,871	0,025	35,248	0,000			1,748
P13.2	0,484	0,080	6,056	0,000			1,045
P13.3	0,867	0,025	35,204	0,000			1,746
P14					0,864	0,68	
P14.1	0,773	0,036	21,390	0,000			1,435
P14.2	0,862	0,021	40,786	0,000			1,649
P14.3	0,837	0,030	28,331	0,000			1,656
P1					0,851	0,59	
P1.1	0,825	0,031	26,423	0,000			1,752
P1.2	0,839	0,031	27,149	0,000			1,896
P1.3	0,731	0,041	17,829	0,000			1,352
P1.4	0,663	0,055	11,995	0,000			1,312
P8					0,777	0,537	
P8.3	0,764	0,034	22,289	0,000			1,189
P8.4	0,708	0,058	12,182	0,000			1,205
P8.5	0,726	0,049	14,965	0,000			1,134

Source: Elaborated by the author

The Standardized Root Mean Square Residual (SRMR) was used as an adjustment measure. According to Henseler et al. (2014), SRMR is used in PLS models to indicate the model's fit. Hu and Bentler (1999) argue that the model is considered adjusted when it presents values of SRMR below 0.08. The model showed an SRMR value of 0.048, which is considered satisfactory. For Henseler et al. (2014), the model specification errors were avoided. From the results presented, it can be inferred that there is sufficient statistical evidence to demonstrate that the scale has been validated.

Therefore, our final measurement scale is shown in Table 5.8. It comprises 14 practices and 48 items to measure employee involvement in lean manufacturing.

Table 5.8 - Multi-item measurement scale

Practice	Cod	Items
Guarantee that individual's behaviors follow companies' goals (P1)	P1.1	I consider that my individual goals are aligned with the company's objectives.
	P1.2	I consider that my individual goals are aligned with the objectives of the following task/activity/process (internal customer view)
	P1.3	I frequently participate in meetings to align the objectives of my sector, area of expertise, or process.
	P1.4	I agree/I am aware of the results that my managers define for my work.
	~~P1.5~~	~~I can often achieve the objectives my managers set for my work. (item excluded)~~
Top management providing resources (P2)	P2.1	I often have enough time for myself and my team to carry out our lean responsibilities.
	~~P2.2~~	~~I often have access to a dedicated meeting room and dedicated spaces for teams to post communications.~~
	~~P2.3~~	~~I agree that my company seeks to use top talent in lean efforts. In addition, participation is always encouraged but not required.~~
	P2.4	I often have technology resources my company provides to use in lean implementation/efforts.
Middle management support (P4)	P4.1	I often have support from my managers in carrying out improvement tasks
	P4.2	I agree that in my company, senior managers allocate financial and non-financial resources (such as time) to lean efforts.
	P4.3	I can often rely on my senior managers, who always assist us when we have problems.
Intensive use of communication and feedback mechanisms (P5)	P5.1	I can often communicate with anyone in the company, whether they are from another area, process, or department.
	P5.2	I often participate in informal conversations with my managers about issues and improvement initiatives.
	P5.3	I frequently communicate formally (in meetings and emails) with my managers about issues and improvement initiatives.
	P5.4	I often participate in informal conversations with my co-workers about issues and improvement initiatives.
	P5.5	I frequently communicate formally (in meetings and emails) with my co-workers about issues and improvement initiatives.
Education programs, training, and personal development (P6)	P6.1	I often participate in training programs that provide me with knowledge and self-development
	P6.2	I often participate in technical training in lean production.
	P6.3	I often attend training to develop teamwork skills (e.g., communication and interpersonal skills)
	P6.4	I often participate in training with adequate quality.
Continuous development of employee's leadership skills (P7)	P7.1	I am often encouraged to develop leadership skills by my company, which encourages me to use my autonomy on a day-to-day basis.
	P7.2	I agree that my company is concerned with continuously monitoring employee leadership skills and takes action to improve these skills.
	P7.3	I often rely on our leaders to challenge existing ways of doing work and share knowledge about different ways of doing work.
Use of kaizen events (P8)	~~P8.1~~	~~I often participate in kaizen events~~
	~~P8.2~~	~~I often voluntarily participate in continuous improvement (kaizen) events.~~
	~~P8.3~~	~~I am often encouraged to participate in improvement events to solve complex problems.~~
	P8.4	I am often motivated/enjoyed to participate in kaizen events.
	P8.5	I often draw on lessons from previous kaizen events to solve new problems.

Practice	Cod	Items
	P8.6	I frequently engage in product and process improvement efforts.
Use of Reward-based incentives (P9)	P9.1	I often receive, in addition to fixed compensation (salary and annual raises), rewards with a variable payment that depends on performance, collective effort, professionalism, and flexibility.
	P9.2	I frequently receive recognition for my achievements and rewards for innovative ideas.
	P9.3	I am often rewarded for group achievements.
Provide career advancement opportunities for employees (P10)	P10.1	I often advance in my career based on merit and performance
	P10.2	I often have excellent opportunities to improve my career.
	P10.3	My company often guides me to develop skills that help me improve and succeed in my career.
Drive suggestion programs (P11)	P11.1	I frequently suggest ideas for improvement suggestion programs.
	P11.2	I frequently make suggestions for product and process improvements.
	P11.3	I often make suggestions for improving the conditions of the work environment.
Empowerment (job autonomy) (P12)	P12.1	I often feel empowered or empowered to make decisions about my work.
	P12.2	I often have the autonomy to actively contribute to making decisions about my area, process, or department.
	P12.3	I often have autonomy to use my skills and abilities to perform and/or improve my work.
	P12.4	My manager often delegates powers to me to make decisions about my work.
	P12.5	I am often tasked by my manager with making decisions about the area or process in which I work.
Promotion of teamwork (P13)	P13.1	I often get involved in decision-making work teams.
	P13.2	I often feel satisfied with the achievements achieved by the work team I am part of.
	P13.3	I often contribute to the group decision-making process.
Multifunctional employee (job rotation) (P14)	P14.1	I am often trained in more than one area of work
	P14.2	I often receive cross-training, ensuring I am not an expert in just one activity.
	P14.3	I often participate in cross-training to develop multiple skills.
Encourage innovation and technologies (P15)	P15.1	I agree that my company uses information technology systems as a source of knowledge to inspire and engage me in lean change.
	P15.2	I am often involved in activities that use active methodologies as a source of knowledge to inspire me to engage in lean change.
	P15.3	I agree that my company invests in new technologies, such as comprehensive modeling tools and specialty software, in lean efforts.
	P15.4	I frequently use collaborative technology with tools and systems designed and made available by my company to facilitate group work in the office and remotely.

Source: elaborated by the author

5.4 DISCUSSION

The primary contribution of this article is to develop and validate a scale to measure employee involvement in lean manufacturing. Other studies in the literature emphasize the importance of studies focusing on the level of employee involvement for the successful implementation and sustainability of Lean (VAN ASSEN, 2021).

The proposed scale can be used in future studies to track operator involvement in lean manufacturing in manufacturing companies implementing lean manufacturing. Furthermore, this scale can be used in practice to evaluate the effectiveness of employee involvement programs.

The initial stage of the validation process comprised 15 practices and 72 items; the final scale comprised 14 practices and 48 items. This reduction is practical because a shorter scale reduces the number of respondents and increases response rates. By creating a more concise scale without sacrificing validity and reliability, we developed a practical tool for measuring employee involvement in lean manufacturing.

While creating a more concise scale throughout the reduction process, ensuring the validity and reliability of the scale was a primary concern. Statistical techniques, such as factor analysis or expert judgment, were employed to identify and retain items demonstrating high factor loadings, content validity, and internal consistency. By carefully selecting the most informative and reliable articles, the reduced scale still maintains its ability to measure the desired constructs accurately. It is important to note that this reduction does not overlook the essential aspects we intended to evaluate. Therefore, during the four steps of our research, we were able to:

• Eliminate Redundancy: During the validation process, it was observed that multiple items within the initial scale were essentially measuring the same underlying construct or concept. This redundancy in the items indicated that the ideas they represented were widespread in the literature. Therefore, to streamline the scale and improve its brevity, redundant items were removed while ensuring that the essential aspects of each construct were still captured.

• Retent the key aspects of employee involvement in lean manufacturing: Despite reducing the number of practices and items, the final scale was carefully designed to retain the crucial elements of each practice. This was achieved by maintaining representative items that captured the core elements and comprehensively evaluated the practices.

About the practice of “Guarantee that individual’s behaviors follow companies’ goals” (P1), we sought to assess whether the employees' goals were aligned with the company's goals and whether these goals are well understood and accepted by employees (GAGNON et al., 2008). For this practice, one item was not confirmed during the validation process - P1.5, which refers to " I am often able to achieve the objectives set by my managers about my work". This item was possibly not confirmed due to its similarity with item P1.2, “I consider that my individual goals are aligned with the objectives of the next task/activity/process (internal customer view)," in which both items deal with the operator's objectives attendance.

Regarding the "Making job resources available" (P2) practice, the scale items seek to measure, from the perspective of the operators, whether the company provides financial and non-financial resources such as time and dedicated rooms for improvement teams, using skills and encouraging participation in a non-arbitrary way (HUO; BOXALL, 2018, DELLVE et al., 2018). For this practice, two items were not confirmed during the validation process: P2.2 "I often have access to a dedicated room for meetings and dedicated spaces for teams to post communications" and P2.3 "I agree that my company seeks to use top talent in lean efforts. In addition, participation is always encouraged, but not required". Item P2.2 was possibly not confirmed due to the practice referring to the availability of resources and the item being directed to the company's infrastructure. Item P2.3 was possibly not guaranteed due to its similarity with item P7.2: "I agree that my company is concerned with continuously monitoring employee leadership skills and takes actions to improve these skills," referring to the practice "Continuous development of employee's leadership skills" in which both emphasize the development and encouragement of operators' skills.

In the "management support" (P4) practice, the scale items seek to understand how employees perceive the support and availability of management to help with matters related to lean (BERGQUIST; WESTERBERG, 2014), SOETARA et al. (2018), ROSLIN et al. (2019), DELLVE et al. (2018); RACHMAN; RATNAYAKE, 2019).

The practice "Intensive use of communication and feedback mechanisms" (P5) was also confirmed, and the scale items seek to measure the usage of formal and informal conversations to involve employees in daily decisions in the company (VICENTE et al., 2015, AHLSTRAND; GAUTIÉ, 2022, KLEIN et al., 2022).

The practice "Education programs, training, and personal development" (P6) seeks to measure the employee's perception of their participation in training and development of skills for work and the continuous "development of employee's leadership skills" (P7) practice seeks to measure how much operators feel encouraged to use autonomy in their day-to-day tasks to seek and make systematic improvements in work processes (ANAND et al., 2012).

The "Use of kaizen events" (P8) practice seeks to measure the participation and voluntary motivation of operators in improvement events (VO et al., 2019; KUMAR; MATHIYAZHAGAN, 2020; WICKRAMASINGHE; CHATHURANI, 2020). For this practice, three items were confirmed during the validation process: P8.1 “I often participate in kaizen events”, P8.2 “I often voluntarily participate in continuous improvement (kaizen) events,” and P8.3 “I am often encouraged to participate in improvement events to solve complex problems.” This item was possibly not confirmed because two items had the same meaning as the others items about the same practice: P8.4 “I am often motivated/enjoyed to participate in kaizen events,” P8.5 “I often draw on lessons from previous kaizen events to solve new problems” and P8.6 “I frequently engage in product and process improvement efforts.” The large number of items saying the same thing indicates the widespread presence of similar concepts in the literature.

“Reward-based incentives” (P9) practice measures operators' satisfaction with individual and group incentives for innovative ideas (BOXALL; WINTERTON, 2018; SOETARA et al., 2018).

The practice “Provide career advancement opportunities for employees” (P10) seeks to measure how operators feel they can progress in their career based on their merit and performance and how much they perceive that the company is concerned with offering opportunities for their development and professional success (BHATTACHARYA, 2015). “Drive suggestion programs” (P11) practice seeks to measure how much operators suggest new ideas for the product, process, and development of their work (ROSLIN et al., 2019, CHOPRA; FERNANDO, 2020, BERALDIN et al., 2022).

The “Promotion of Teamwork” (P13) practice measures how satisfied operators are with being involved and contributing to decision groups (BERALDIN et al., 2022, NARAYANAN et al., 2022) . The “Multifunctional employee (job rotation)” practice (P14) measures whether operators perceive that they are trained in more than one area and that, with this, they develop multiple skills (SIGNORETTI; SACCHETTI, 2020, TALIB et al., 2020, NARAYANAN et al., 2022). Finally, the “encourage innovation and technologies” (P15) practice seeks to measure how much operators perceive the company's investment in technologies and how much this contributes to information and increased knowledge through collaborative technologies (MOICA et al., 2019, PEREIRA; LIKER, 2021).

5.5 CONCLUSIONS

5.5.1 Final Remarks

This paper proposes a novel multi-dimensional scale to measure employee involvement practices in lean manufacturing. Numerous papers have represented practices referring to employee involvement. However, there is a lack of research that analyses in-depth the practices that drive employee involvement in a lean context. The proposed scale covers practice categories related to getting the necessary resources and training people, enriching people, implementing formal practices, and align goals.

Besides, most such studies followed an exploratory (ad hoc) approach, not adopting the state-of-the-art research method concerning scale development. This research used a robust and systematic methodological approach to develop an instrument for measuring employee involvement in implementing lean manufacturing in companies based on an extensive systematic literature review. The proposed scale is composed of practices and items, making the application of the instrument less exhaustive and more efficient, resulting in a higher probability of adoption by practitioners.

The article aimed to develop a generic scale that can be applied in any manufacturing industry, irrespective of its production process. Accordingly, the survey developed a set of generic questions for topics common to any production process. It assessed the consistency of the managerial approach to managing them, not using the best or specific context-dependent technical practices.

Otherwise, it would have been necessary to include items that addressed the particularities of the processes of each industry. It is believed that the potential users of the proposed scale will assess their company's employee involvement in lean manufacturing implementation performance because the topics addressed are generic and follow the literature items and approach.

Furthermore, the proposed scale was tested via survey with academics and lean professional managers from different industries, thus ensuring that both the practices and the assessed items are valid and reliable. However, the items were evaluated by Brazilian experts, which can bring to the assertive questions more focused on this culture.

5.5.2 Theoretical contributions and managerial implications

In general terms, the development of this scale is relevant for both theory and practice. First, our contribution explicitly expands the dimensions of the literature about employee involvement in lean manufacturing. Besides providing a list of practices and measures, this study employs a rigorous method with complementary steps, including a systematic literature review, panels of experts, and survey and statistical analysis to propose a novel robust scale.

As a result, its generic character allows it to be employed in diverse contexts, including different sectors of activities in manufacturing from various geographical regions on the planet. In particular for decision-makers, the proposed scale may serve as a diagnostic tool to first map employee involvement practices adoption and then identify which kind of employee involvement practices are most widely adopted, which ones need more attention, or which new ones can be further implemented.

Based on this diagnosis, companies can later define new strategies for employee involvement in lean manufacturing implementation. When implementing employee involvement practices, companies will be able to survey and enjoy the reduction of resistance to change related to implementing lean manufacturing, in addition to increased engagement and productivity. With the perception of these benefits, there is a higher likelihood that these organizations will become more engaged with lean manufacturing, thus driving continuous improvement in general.

Besides, the possibility of using the scale as a benchmarking tool to compare the adoption of practices among companies belonging to the same sector and different ones is also highlighted. Finally, it should be noted that using the scale promotes a better quality of life in society by using it as a basis for creating strategies to motivate employees.

5.5.3 Limitations and future research

The most important limitation of this study is using a non-probabilistic sampling approach in the surveys. This fact was believed to be minimized due to the reasonable number of valid cases in the first and second surveys, 94 and 176, respectively.

However, depending on the region or company in which it is applied, managers may notice differences in the importance or difficulty of implementing these practices.

Future research may employ other methods, such as a simple, systematic, and stratified random sample. Additionally, it is essential to highlight that the scale can be applied in future causal studies to measure the relationship of employee involvement with emerging future themes, such as investigating how employee involvement motivates the adoption of Industry 4.0 technologies as a promising research avenue. Besides these suggestions, future research could also explore the synergies and the relationship between employee involvement and others, such as Lean health care or Lean construction, as well as explore employee involvement between the hierarchical levels of the organization.

6 CONCLUSIONS

This section presents the conclusions of the thesis. In general, it covers the overview of the results, the final conceptual model, the research contributions, and the discussion of limitations and proposals for future studies.

6.1 AN OVERVIEW OF THE THESIS RESULTS

This research presented three articles, with Article 1 (Chapter 3) responding to objective SO1 (identifying the employee involvement practices and the role of each of the practices identified), Article 2 (Chapter 4) answering to objectives SO2 (analyse the contextual relationship and dependency amongst practices for increasing employee involvement and propose path companies should follow to involve employees in LM efforts) and Article 3 (Chapter 5) focused on objective SO3 (develop and validate a measurement scale reflecting employee involvement in lean.

While Chapter 3 identified 15 practices that influence employee involvement in implementing lean manufacturing, Chapter 4 identified a hierarchy relationship between these practices. Chapter 5 considered this relationship to develop and validate a scale to measure the level of employee involvement in lean manufacturing.

Chapter 3 presented a Systematic Literature Review (SLR) carried out in 90 articles to identify the practices and the role of each one for employee involvement in lean manufacturing. As a result, 15 practices were identified. In addition, to ensure the reliability of the list of practices presented, the practices were validated through expert interviews. Finally, the results of Chapter 3 served as the basis for Chapters 4 and 5.

Chapter 4 presented, based on the practices identified in Chapter 3 and through expert opinion and multicriteria decision-making methods, the path to be followed for implementing these practices that guide the involvement of employees in LM efforts. Organization Change Management (OCM) was used as a basis, being one of the factors to sustain the actions of implementation and support of the proposed changes. As a result, it was found that for the involvement of employees in lean manufacturing, it is necessary to follow three steps: (i) getting the necessary resources; (ii) knowledge cultivation; (iii) enriching people; and (iv) implement formal practices and align goals.

Finally, Chapter 5 presented the validation of a scale to measure the level of employee involvement in implementing lean manufacturing. A q-sorting and a survey were carried out to refine and validate this scale.

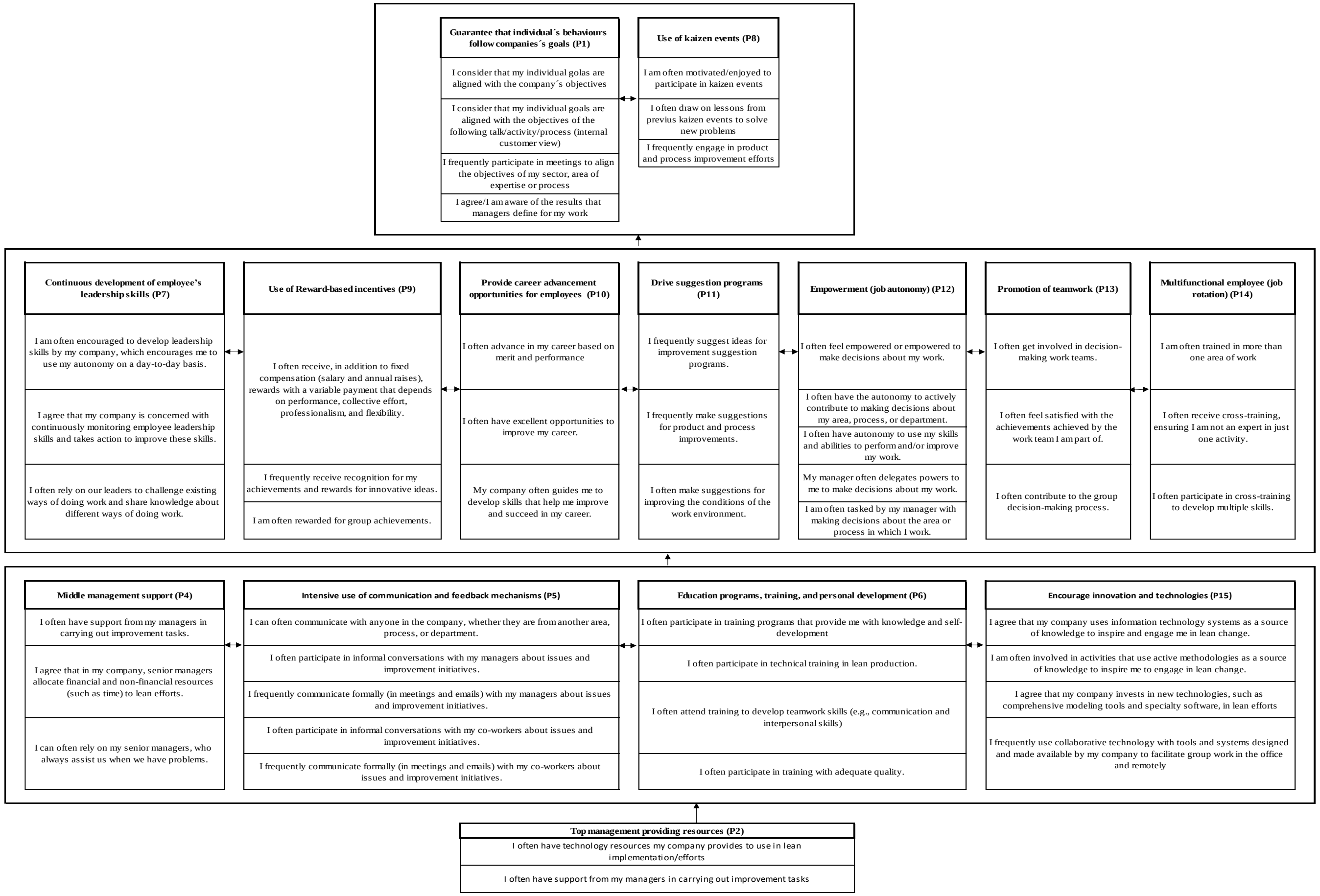
Therefore, the research seeks to understand which practices are necessary to involve employees in implementing lean manufacturing, their relationship, and how they can be measured. The practices were identified in Chapter 3. In Chapter 4, the relationships between these practices were understood and used to build a scale to measure employee involvement, in Chapter 5. In this way, it was possible to understand the need for employee involvement to implement lean manufacturing successfully.

6.2 FINAL CONCEPTUAL MODEL, PROPOSED ANALYSIS STRUCTURE AND CONTRIBUTIONS

After carrying out the literature review (Chapter 3), it was noticed that the discussion about the role of employee involvement in the implementation of lean manufacturing was restricted to describing the importance of this practice in some context. We observed a lack of studies that look in depth at practices used to involve employees in lean manufacturing. In this sense, it was observed that the involvement of employees is an important practice, but the practices to achieve this involvement were not addressed in full. In addition, it was noted the need to understand in depth the relationship between these practices and to create an instrument to measure their level of implementation to be able to identify which practices need greater attention by companies and the path that should be compelled to achieve this achieve a higher level of employee involvement in the implementation of lean manufacturing. Thus, this study was undertaken to fill this research gap.

The conceptual model shown in Figure 6.1 is provided to systematize the thesis contributions. This model demonstrates how the research allowed the analysis of employee involvement to be studied not only as a secondary practice but as an essential practice for implementing lean, thus allowing a more in-depth study on this topic.

Figure 6.1- Conceptual model



Source: elaborated by the author.

The proposed conceptual model is based on the integration of the results of the 3 papers.

For managers to use this model, they must first measure the level of employee involvement, using the questionnaire in Annex 1 with operators and employees involved in lean implementation. The level can be obtained from the average of the operators' responses. Once you have found the level of practices, you can observe which of these practices deserve greater attention so that actions can be taken to improve employees' perception of them and consequently improve their involvement. Once the practices with the lowest level of implementation have been identified, the manager must observe among those with the lowest level which ones should be prioritized based on the priority roadmap presented, respecting the implementation stages, since the implementation of the practices in the first stage facilitate the implementation of practices of the second, third and fourth stages, respectively.

This analysis shows an implementation roadmap based on the order of implementation priority to achieve effective employee engagement. This roadmap consists of four steps to be followed:

Step 1: Getting necessary research - Represented by the base step of the model, it consists of implementing the "Top management providing resources" practice. To measure the level of practice, the statements must be used as represented in Table 6.1.

Table 6. 1 Getting necessary resources

Practice	Item
Top management providing resources (P2)	I often have technology resources my company provides to use in lean implementation/efforts
	I often have support from my managers in carrying out improvement tasks

Source: Elaborated by the author

Step 2: Knowledge cultivation – Represented by the second stage of the model, it consists of the implementation of practices that seek to encourage and provide knowledge to employees, which are: middle management support, intensive use of communication and feedback mechanisms, education programs, training, and personal development and encourage innovation and technologies. Among the four practices present in this stage, priority should be given to those with the lowest level of implementation. To measure the level of practice, the statements must be used as represented in Table 6.2.

Table 6. 2 Knowledge cultivation

Practice	Item
Middle management support (P4)	I often have support from my managers in carrying out improvement tasks. I agree that in my company, senior managers allocate financial and non-financial resources (such as time) to lean efforts I can often rely on my senior managers, who always assist us when we have problems.
Intensive use of communication and feedback mechanisms (P5)	I can often communicate with anyone in the company, whether they are from another area, process, or department. I often participate in informal conversations with my managers about issues and improvement initiatives. I frequently communicate formally (in meetings and emails) with my managers about issues and improvement initiatives. I often participate in informal conversations with my co-workers about issues and improvement initiatives. I frequently communicate formally (in meetings and emails) with my co-workers about issues and improvement initiatives.
Education programs, training, and personal development (P6)	I often participate in training programs that provide me with knowledge and self-development I often participate in technical training in lean production. I often attend training to develop teamwork skills (e.g., communication and interpersonal skills) I often participate in training with adequate quality.
Encourage innovation and technologies (P15)	I agree that my company uses information technology systems as a source of knowledge to inspire and engage me in lean change. I am often involved in activities that use active methodologies as a source of knowledge to inspire me to engage in lean change. I agree that my company invests in new technologies, such as comprehensive modelling tools and specialty software, in lean efforts I frequently use collaborative technology with tools and systems designed and made available by my company to facilitate group work in the office and remotely

Source: Elaborated by the author

Step 3: enriching people - Represented by the third stage of the model, it consists of implementing practices that seek to enrich employees, which can be explained as greater diversity in work content achieved by giving autonomy to employees, which is useful for the organization to increase the interest and commitment of its employees (Tumi; Hasan; Khalid, 2021). The practices that were associated with this group were: continuous development of employee's leadership skills, use of reward-based incentives, provide career advancement opportunities for employees, drive suggestion programs, empowerment, promotion teamwork and multifunctional employee (job rotation), as shown in Table 6.3.

Table 6. 3 enriching people

Practice	Item
Continuous development of employee's leadership skills (P7)	I am often encouraged to develop leadership skills by my company, which encourages me to use my autonomy on a day-to-day basis. I agree that my company is concerned with continuously monitoring employee leadership skills and takes action to improve these skills. I often rely on our leaders to challenge existing ways of doing work and share knowledge about different ways of doing work.
Use of Reward-based incentives (P9)	I often receive, in addition to fixed compensation (salary and annual raises), rewards with a variable payment that depends on performance, collective effort, professionalism, and flexibility I frequently receive recognition for my achievements and rewards for innovative ideas. I am often rewarded for group achievements.
Provide career advancement opportunities for employees (P10)	I often advance in my career based on merit and performance I often have excellent opportunities to improve my career. My company often guides me to develop skills that help me improve and succeed in my career.
Drive suggestion programs (P11)	I frequently suggest ideas for improvement suggestion programs. I frequently make suggestions for product and process improvements. I often make suggestions for improving the conditions of the work environment.
Empowerment (job autonomy) (P12)	I often feel empowered or empowered to make decisions about my work. I often have the autonomy to actively contribute to making decisions about my area, process, or department. My manager often delegates powers to me to make decisions about my work. I am often tasked by my manager with making decisions about the area or process in which I work.
Promotion of teamwork (P13)	I often get involved in decision-making work teams. I often feel satisfied with the achievements achieved by the work team I am part of. I often contribute to the group decision-making process.
Multifunctional employee (job rotation) (P14)	I am often trained in more than one area of work I often receive cross-training, ensuring I am not an expert in just one activity. I often participate in cross-training to develop multiple skills

Source: Elaborated by the author

Step 4: Implement formal practices and align goals - Represented by the fourth stage of the model, it consists of the implementation of practices that seek to implement formal practices and align objectives between the company and employees. The practices associated with this group were: guarantee that individual’s behaviors follow companies’ goals and user of kaizen events, as shown in Table 6.4.

Table 6. 4 Implement formal practices and align goals

Practice	Item
Guarantee that individual´s behaviours follow companies´ goals (P1)	I consider that my individual goals are aligned with the company´s objectives I consider that my individual goals are aligned with the objectives of the following talk/activity/process (internal customer view) I frequently participate in meetings to align the objectives of my sector, area of expertise or process I agree/I am aware of the results that managers define for my work
User of kaizen events (P8)	I am often motivated/enjoyed to participate in kaizen events I often draw on lessons from previous kaizen events to solve new problems I frequently engage in product and process improvement efforts

Source: Elaborated by the author

Finally, the model demonstrates a management tool for making decisions about which practices to increase employee involvement in the implementation of lean manufacturing should be prioritized, based on the level of implementation of each of them and a practice prioritization roadmap, in order to achieve greater involvement of its employees and consequently a more sustainable implementation of lean manufacturing. In this way, it helps managers gauge employee engagement and identify areas for improvement.

In short, in addition to having a tool for measuring the level of employee involvement, managers can also identify which practices have a lower level of implementation and which of them need to be prioritized for improvement.

In addition to the conceptual model, based on these results, it was also possible to contribute to the Organizational Change Management (OCM) theory to help in the decision of actions related to the involvement of employees, comprising a way to ensure the involvement of employees in the process. LM establishment and maintenance process emerging, thus, as a crucial factor in the creation of a climate of change, being one of the base factors to sustain the actions of implementation and support of the proposed changes.

Another important aspect is that the results of the three articles made it possible to contribute both to the literature and to practice. It is considered that the research advanced the literature, mainly when discussing employee involvement based on lean manufacturing, extending the concepts of OCM theory in this context.

Furthermore, the proposed prioritization and measurement frameworks allow researchers and practitioners to understand in depth which practices should be prioritized for employee involvement in the context of lean in future studies.

6.3 LIMITATIONS AND OPPORTUNITIES FOR FUTURE RESEARCH

The limitations of the thesis are as follows. First, systematic literature (Chapter 3) review processes are naturally subject to researchers' biases in extracting and analysing results. In Chapter 4, four groups of practices were suggested. However, these groups were only named intuitively, a more robust classification study must be carried out. In Chapters 5 and four should be considered exploratory, as we used only five companies and only in the Brazilian context due to the great difficulty in getting companies to apply the questionnaire with their operators. Third, Chapter 5 considers only the reality of Brazilian manufacturing industry operators.

In this sense, some gaps have not yet been discovered. First, research can be carried out to contemplate a statistically adequate sample of manufacturing operators and consider the reality of different countries to validate the proposed structures. Second, the developed measurement scale can be adapted for empirical analysis of employee involvement in a service context or public sector in future research, given the potential of this scale for measuring the level of employee involvement. In addition, the relationship between employee involvement, the companies' productivity, and the level of lean manufacturing implementation can be studied.

REFERENCES

ACHANGA, P.; SHEHAB, E.; ROY, R.; NELDER, G. Critical success factors for lean implementation within SMEs, **Journal of Manufacturing Technology Management**, v. 17 n. 4, pp. 460-471, 2005.

ADLER, P. S.; GOLDOFTAS, B.; LEVINE, D. I. Ergonomics, employee involvement, and the Toyota Production System: A case study of NUMMI's 1993 model introduction. **ILR Review**, v. 50, n. 3, p. 416-437, 1997.

AGHAEI CHADEGANI, A., SALEHI, H., MD YUNUS, M.M., FARHADI, H., FOOLADI, M., FARHADI, M., ALE EBRAHIM, N. A comparison between two main academic literature collections: Web of science and scopus databases. **Asian Soc. Sci**. v. 9, n. 5, p18–26, 2013.

AGYABENG-MENSAH, Y., TANG, L., AFUM, E., BAAH, C. and DACOSTA, E. Organisational identity and circular economy: Are inter and intra organisational learning, lean management and zero waste practices worth pursuing?, **Sustainable Production and Consumption**, Vol. 28, pp. 648–662, 2021. doi: 10.1016/j.spc.2021.06.018.

AHLSTRAND, R., GAUTIÉ, J. Labour–management relations and employee involvement in lean production systems in different national contexts: A comparison of French and Swedish aerospace companies. **Econ. Ind. Democr,** 2022. https://doi.org/10.1177/0143831X221101427

AHMAD, S.; SCHROEDER, R. G.; SINHA, K. The role of infrastructure practices in the effectiveness of JIT practices: implications for plant competitiveness. **Journal of Engineering and Technology Management**, v. 20, n. 3, p. 161-191, 2003. https://doi.org/10.1016/S0923-4748(03)00017-1

ALEFARI, M., ALMANEI, M., SALONITIS, K. Lean manufacturing, leadership and employees: the case of UAE SME manufacturing companies. **Prod. Manuf. Res**. v.8, p. 222–243, 2020. https://doi.org/10.1080/21693277.2020.1781704

ANAND, G.; CHHAJED, D.; DELFIN, L. Job autonomy, trust in leadership, and continuous improvement: An empirical study in health care. **Operations Management Research**, v. 5, n. 3–4, p. 70–80, 2012. https://doi.org/10.1007/s12063-012-0068-8

ANGELIS, J. J.; FERNANDES, B. Lean practices for product and process improvement: involvement and knowledge capture. In: **Advances in Production Management Systems**. Springer, Boston, MA, 2007. p. 347-354. https://doi.org/10.1108/20401461211223740

AOUN, M.; HASNAN, N. **Lean production and TQM : Complementary or Contradictory Driving Forces of Innovation Performance** ? v. 5, n. 4, 2013.

APPELBAUM, E; BERG, P. High-performance work systems and labor market structures. In: **Sourcebook of Labor Markets: Evolving Structures and Processes**. Boston, MA: Springer US, 2001. p. 271-293.https://doi.org/10.1007/978-1-4615-1225-7_11

ARGIYANTARI, B., SIMATUPANG, T.M., BASRI, M.H. The lean framework for supporting the pharmaceutical supply chain transformation. **Int. J. Serv. Oper. Manag.** v.42, p. 454–479, 2022. https://doi.org/10.1504/ijsom.2022.125027

ARMITAGE, A.; KEEBLE-ALLEN, D. Undertaking a structured literature review or structuring a literature review: tales from the field. In: **Proceedings of the 7th European Conference on Research Methodology for Business and Management Studies: ECRM2008, Regent's College, London**. p. 35. 2008.

ASSARLIND, Marcus. Analysis of an improvement program for MSMEs. **Journal of Manufacturing Technology Management**, v. 26, n. 8, p. 1107-1125, 2015. https://doi.org/10.1108/JMTM-04-2013-0044

AZALANZAZLLAY, N.N., LIM, S.A.H., ABIDIN, U.F.U.Z., ANASS, C. Uncovering Readiness Factors Influencing the Lean Six Sigma Pre-Implementation Phase in the Food Industry. **Sustain**. v.14, 2022. https://doi.org/10.3390/su14148941

BÄCKSTRÖM, I.; LINDBERG, M. Varying involvement in digitally enhanced employee-driven innovation. **European Journal of Innovation Management**, 2019.

BAGAL, Suhas; DASGUPTA, Hirak. Factors Effective for Implementation of Lean in Manufacturing Organizations of India. **Cardiometry**, n. 24, p. 510-516, 2022.

BAGNI, G., GODINHO FILHO, M., THÜRER, M., STEVENSON, M. Systematic review and discussion of production control systems that emerged between 1999 and 2018. **Prod. Plan. Control.** v. 32, p. 511–525, 2021. https://doi.org/10.1080/09537287.2020.1742398

BAIRD, M.; LANSBURY, R. D. Emerging production systems and industrial relations: Confusion, diffusion, and exclusion? **Human Factors and Ergonomics in Manufacturing & Service Industries**, v. 8, n. 2, p. 141-153, 1998. https://doi.org/10.1002/(SICI)1520-6564(199821)8:2<141::AID-HFM4>3.0.CO;2-3

BAMBER, Greg J. et al. Human resource management, Lean processes and outcomes for employees: a research agenda. **The International Journal of Human Resource Management.** 2014.

BANDALOS, D.L. **Measurement theory and applications for the social sciences.** Guilford Press, New York, 2018.

BANDALOS, D.L., Finney, S.J. **Factor analysis: Exploratory and confirmatory, in: n** Routledge, New York, pp. 98–122, 2019.

BANERJEE, Y., TUFFNELL, C. and ALKHADRAGY, R. Mento's change model in teaching competency-based medical education, **BMC Medical Education**, Vol. 19 No. 1, p. 472, 2019. doi: 10.1186/s12909-019-1896-0.

BÁNYAI, T.; BÁNYAI, Á. Modeling of just-in-sequence supply of manufacturing processes. **MATEC Web Conf.** 2017.

BEAUVALET, G.; HOUY, T. Research on HRM and lean management: a literature survey. **International Journal of Human Resources Development and Management**, v. 10, n. 1, p. 14-33, 2010.

BELLISARIO, A.; PAVLOV, A Performance management practices in lean manufacturing organizations: a systematic review of research evidence. **Production Planning & Control**, v. 29, n. 5, p. 367-385, 2018.

BENKARIM, A., IMBEAU, D. Organizational commitment and lean sustainability: Literature review and directions for future research. **Sustain.** v.13, 2021. https://doi.org/10.3390/su13063357

BERALDIN, A. R.; DANESE, P.; ROMANO, P. Employee involvement for continuous improvement and production repetitiveness: a contingency perspective for achieving organizational outcomes. **Production Planning and Control**, v.33, p.323–339, 2022. https://doi.org/10.1080/09537287.2020.1823024

BERALDIN, A.R., DANESE, P., ROMANO, P. An investigation of the relationship between lean and well-being based on the job demands-resources model. **Int. J. Oper. Prod. Manag**. v.39, p. 1295–1322, 2019. https://doi.org/10.1108/IJOPM-05-2019-0377

BERG, R.; SMITH, D. The formula: World-class manufacturing for hybrid thin-film component production. **IEEE transactions on semiconductor manufacturing**, v. 6, n. 2, p. 170-177, 1993. https://doi.org/10.1109/66.216936

BERGQUIST, B.; WESTERBERG, M. Testing for motivation to engage in improvements – a conceptual framework and an initial empirical test. **Total Quality Management and Business Excellence**, v. 25, n. June 2015, p. 1224–1235, 2014. https://doi.org/10.1080/14783363.2013.776761

BERLEC, T. et al. Methodology to Facilitate Successful Lean Implementation. **Strojniski Vestnik/Journal of Mechanical Engineering**, v. 63, 2017. https://doi.org/10.5545/sv-jme.2017.4302

BHATTACHARYA, Y. Employee engagement in the shipping industry: a study of engagement among Indian officers. **WMU Journal of Maritime Affairs**, v. 14, n. 2, p. 267–292, 2015. https://doi.org/10.1007/s13437-014-0065-x

BIANCO, Débora et al. Unlocking the relationship between lean leadership competencies and industry 4.0 leadership competencies: an ISM/fuzzy MICMAC approach. **IEEE Transactions on Engineering Management**, 2021.

BILTON, C., **Management and Creativity**, Blackwell Publishing, Oxford, 2007.

BIRDI, K., CLEGG, C., PATTERSON, M., ROBINSON, A., STRIDE, C.B., WALL, T.D., WOOD, S.J. The impact of human resource and operational management practices on company productivity: A longitudinal study. **Pers. Psychol**. v. 61, p. 467–501, 2008. https://doi.org/10.1111/j.1744-6570.2008.00136.x

BOURANTA, N., PSOMAS, E. and ANTONY, J. “Human factors involved in lean management: a systematic literature review”, **Total Quality Management and Business Excellence**, Vol. 33, 2022. Nos 9-10, pp. 1113-1145.

BOXALL, P., HUO, M. Fostering the high-involvement model of human resource management: what have we learnt and what challenges do we face? **Asia Pacific J. Hum. Resour**. v.60, p. 41–61, 2022. https://doi.org/10.1111/1744-7941.12305

BOXALL, P., WINTERTON, J. Which conditions foster high-involvement work processes? A synthesis of the literature and agenda for research. **Econ. Ind. Democr**. v.39, p. 27–47, 2018. https://doi.org/10.1177/0143831X15599584

BOYER, K.K. An assessment of managerial commitment to lean production, **International Journal of Operations & Production Management**, Vol. 16 No. 9, pp. 48-59, 1996.

BRKIC, S. V.; TOMIC, B. Employees factors importance in Lean Six Sigma concept. **The TQM Journal**, v. 28, n. 5, p. 774-785, 2016. https://doi.org/10.1108/TQM-10-2015-0131

BROWN, C.; REICH, M. When does union-management cooperation work? A look at NUMMI and GM-Van Nuys. **California Management Review**, v. 31, n. 4, p. 26-44, 1989. https://doi.org/10.2307/41166581

BRYMAN, A., 2012. **Social Research Methods**, 4th ed. Oxford University Press, Oxford.

BUCHINGER, D.; CAVALCANTI, G. A. de S.; HOUNSELL, M da S. Mecanismos de busca acadêmica: uma análise quantitativa. **Revista Brasileira de Computação Aplicada**, v. 6, n. 1, p. 108-120, 2014.

BUENO, A., FILHO, M.G., CARVALHO, J.V., CALLEFI, M. Smart Production Planning and Control Model, in: **Smart Innovation, Systems and Technologies**. pp. 253–267, 2022. https://doi.org/10.1007/978-981-16-5063-5_21

BUENO, A., GODINHO FILHO, M., FRANK, A.G. Smart production planning and control in the Industry 4.0 context: A systematic literature review. **Comput. Ind. Eng**. v.149, p. 1067-74, 2020. https://doi.org/10.1016/j.cie.2020.106774

CABRAL, C.; DHAR, R. L. Green competencies: Construct development and measurement validation. **Journal of Cleaner Production**, v. 235, p. 887-900, 2019.

CALLEFI, M.H.B.M., GANGA, G.M.D., GODINHO FILHO, M., QUEIROZ, M.M., REIS, V., DOS REIS, J.G.M. Technology-enabled capabilities in road freight transportation systems: A multi-method study. **Expert Syst. Appl**. v. 203, p.1174-97,

2022. https://doi.org/10.1016/j.eswa.2022.117497

CAPPELLI; NEUMARK. “Do High-Performance Work Practices Improve Establishment-Level Outcomes?”. **Industrial and Labor Relations Review.** v. 54. n. 4, p. 737–775, 2001.

CARDOSO, R.D.R., PINHEIRO DE LIMA, E., GOUVEA DA COSTA, S.E. Identifying organizational requirements for the implementation of Advanced Manufacturing Technologies (AMT). **J. Manuf. Syst.** v.31, p. 367–378, 2012. https://doi.org/10.1016/j.jmsy.2012.04.003

CHADEGANI, A. et al. A comparison between two main academic literature collections: Web of Science and Scopus databases. **Asian social science**, v. 9, n. 5, p. 18-26, 2013.

CHEN, P.K., LUJAN-BLANCO, I., FORTUNY-SANTOS, J., RUIZ-DE-ARBULO-LÓPEZ, P. Lean manufacturing and environmental sustainability: The effects of employee involvement, stakeholder pressure and iso 14001. **Sustain**. v. 12, 1–19, 2020. https://doi.org/10.3390/su12187258

CHENG, T. C. E. Some thoughts on the practice of just-in-time manufacturing. **Production Planning and Control**, v. 2, n. 2, p. 167–178, 1991. https://doi.org/10.1080/09537289108919344

CHENG, T. C. E.; MUSAPHIR, H. Some implementation experiences with just-in-time manufacturing. **Production Planning & Control**, v. 4, n. 2, p. 181-192, 1993. https://doi.org/10.1080/09537289308919436

CHESBROUGH, H. To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective. **Industrial Marketing Management**, v. 88, p. 410-413, 2020.

CHOPRA, S.; FERNANDO, J. Modeling employees behavior intention with the adoption of a suggestion system for lean initiatives. **J. Technol. Manag. Appl. Eng.** v. 36, p. 1–14, 2020.

CLIFFORD, G. P.; SOHAL, A. S. Developing self-directed work teams. **Management Decision**, v. 36, n. 2, p. 77-84, 1998. https://doi.org/10.1108/00251749810204151

COSTA, L.B.M., GODINHO FILHO, M., FREDENDALL, L.D., GANGA, G.M.D. Lean six sigma in the food industry: Construct development and measurement validation. **Int. J. Prod. Econ**. v. 231, 2021. https://doi.org/10.1016/j.ijpe.2020.107843

DAILY, B.F., HUANG, S.C. Achieving sustainability through attention to human resource factors in environmental management. **Int. J. Oper. Prod. Manag.** v. 21, p. 1539–1552, 2001. https://doi.org/10.1108/01443570110410892

DEDEOGLU, B., TAHERI, B., OKUMUS, F., GANNON, M. Understanding the importance that consumers attach to social media sharing (ISMS):Scale development and validation. **Tour. Manag**. v.76, 2020.

DE KOEIJER, R., STRATING, M., PAAUWE, J., HUIJSMAN, R. A balanced approach involving hard and soft factors for internalizing Lean Management and Six Sigma in hospitals. **TQM J.** 2022. https://doi.org/10.1108/TQM-01-2022-0031

DENIS, D.J.**SPSS data analysis for univariate, bivariate, and multivariate statistics.** Wiley, Hoboken, NJ, 2019.

DE VRIES, H.; VAN DER POLL, H. M. Cellular and organisational team formations for effective Lean transformations. **Production & Manufacturing Research**, v. 6, n. 1, p. 284-307, 2018. https://doi.org/10.1080/21693277.2018.1509742

DEAKINS, D.; BENSEMANN, J. Entrepreneurial learning and innovation: qualitative evidence from agri-business technology-based small firms in New Zealand. **International Journal of Innovation and Learning**, v. 23, n. 3, p. 318-338, 2018.

DELLVE, L., STRÖMGREN, M., WILLIAMSSON, A., HOLDEN, R.J., ERIKSSON, A. Health care clinicians' engagement in organizational redesign of care processes: The importance of work and organizational conditions. **Applied ergonomics**, v. 68, p. 249-257, 2018. https://doi.org/10.1016/j.apergo.2017.12.001

DENYER, D.; TRANFIELD, D. Producing a systematic review. In: BUCHANAN, David.; BRYMAN, Alan. (Eds.). **The sage handbook of Organizational Research Methods**. London: Sage Publications, 2009, p. 671-689.

DEVELLIS, R.F., 2022. Scale development: Theory and applications, 5th ed. Sage Publications, Thousand Oaks.

DILLMAN, D.A., SMYTH, J.D., CHRISTIAN, L.M. **Internet, phone, mail, and mixed mode surveys:** The tailored design method. Wiley, Hoboken, NJ, 2014.

DOMBROWSKI, MIELKE, AND SCHULZE, 2012

DURACH, C.F., KEMBRO, J., WIELAND, A. A New Paradigm for Systematic Literature Reviews in Supply Chain Management. **J. Supply Chain Manag**. v.53, p. 67–85, 2017. https://doi.org/10.1111/jscm.12145

ELIZONDO, R. L.; GRABOT, B.; NGOUNA, R. H. Beyond Productivity and Continuous Improvement: Fundamentals required for Lean Complex transformation Unpublished. **IFAC-Papers Online**, v. 49, n. 12, p. 467-472, 2016.

ERRIDA, A.; LOTFI, B,. The determinants of organizational change management success: Literature review and case study. **International Journal of Engineering Business Management**, v. 13, p. 18479790211016273, 2021.

EVANS, C.; REDFERN, D. C. How can employee engagement be improved at the RRG Group? Part 2. **Industrial and Commercial Training**, v. 42, n. 6, p. 330–334, 2010. https://doi.org/10.1108/00197851011070712

FAULKENBERRY, T.J. **Psychological statistics**: The basics. Routledge, New York, 2022.

FIELD, A. **Discovering statistics using IBM SPSS statistics**, 5th ed. Sage Publications, Thousand Oaks, 2018.

FORZA, C. Survey research in operations management: a process-based perspective. **International journal of operations & production management**, 2002.

GAGNON, M. A.; JANSEN, K. J.; MICHAEL, J. H. Employee alignment with strategic change: A study of strategy-supportive behavior among blue-collar employees. **Journal of Managerial Issues**, v. 20, n. 4, p. 425–443, 2008.

GAIARDELLI, P.; RESTA, B.; DOTTI, S.. Exploring the role of human factors in lean management. **International Journal of Lean Six Sigma**, v. 10, n. 1, p. 339-366, 2019.

GAIKWAD, M., AHIRRAO, S., PHANSALKAR, S., KOTECHA, K. Online Extremism Detection: A Systematic Literature Review with Emphasis on Datasets, Classification Techniques, Validation Methods, and Tools. **IEEE Access**. v.9, p. 48364–48404, 2021. https://doi.org/10.1109/ACCESS.2021.3068313

GANSTER, D.C., KIERSCH, C.E., MARSH, R.E., BOWEN, A. Performance-Based Rewards and Work Stress. **J. Organ. Behav. Manage.** v.31, p. 221–235, 2011. https://doi.org/10.1080/01608061.2011.619388

GARCÍA-ALCARAZ, J. L. et al. Effects of Human Factors and Lean Techniques on Just in Time Benefits. **Sustainability**, v. 11, n. 7, p. 1864, 2019.

GODARD, John. High performance and the transformation of work? The implications of alternative work practices for the experience and outcomes of work. **Ind. Labor Relations Review**, v. 54, n. 4, p. 776-805, 2001. https://doi.org/10.1177/001979390105400402

GODINHO FILHO, M.; GANGA, G. M. D.; GUNASEKARAN, A. Lean manufacturing in Brazilian small and medium enterprises: implementation and effect on performance. **International Journal of Production Research**, v. 54, n. 24, p. 7523-7545, 2016. https://doi.org/10.1080/00207543.2016.1201606

GOLHAR, D. Y.; STAMM, C. L. The just-in-time philosophy: a literature review. **The International Journal of Production Research**, v. 29, n. 4, p. 657-676, 1991. https://doi.org/10.1080/00207549108930094

GOLLAN, P.J., KALFA, S., AGARWAL, R., GREEN, R., RANDHAWA, K.,. Lean manufacturing as a high-performance work system: the case of Cochlear. **International Journal of production research**, v. 52, n. 21, p. 6434-6447, 2014. https://doi.org/10.1080/00207543.2014.940430

GÓMEZ PAREDES, F.J., GODINHO FILHO, M., THÜRER, M., FERNANDES, N.O., JABBOUR, C.J.C. Factors for choosing production control systems in make-to-order shops: a systematic literature review. **J. Intell. Manuf**. v.33, p. 639–674, 2022. https://doi.org/10.1007/s10845-020-01673-z

GONELLA, J. dos S. L. GODINHO FILHO, M.; GANGA, G. M. D., LATAN, H.; JABBOUR, C. J. C. Towards a regenerative economy: An innovative scale to measure people's awareness of the circular economy**. Journal of Cleaner Production**, v. 421, p. 138390, 2023. https://doi.org/10.1016/j.jclepro.2023.138390

GONZÁLEZ-BOUBETA, I., PORTELA-CARAMÉS, I., CARLOS PRADO-PRADO, J. Improving through employee participation. The case of a spanish food manufacturer. **J. Ind. Eng. Manag**. v.14, p. 405–424, 2021. https://doi.org/10.3926/jiem.3362

GOVINDAN, K., AZEVEDO, S.G., CARVALHO, H., CRUZ-MACHADO, V. Lean, green and resilient practices influence on supply chain performance: interpretive structural modeling approach. **Int. J. Environ. Sci. Technol**. v.12, p.15–34, 2015. https://doi.org/10.1007/s13762-013-0409-7

GRESSGÅRD, L. J. et al. Use of information and communication technology to support employee-driven innovation in organizations: a knowledge management perspective. **Journal of Knowledge Management**, 2014.

GRIGG, A. Employee empowerment is the main ingredient in a baking company's competitive strategy. **Global Business and Organizational Excellence**, v. 29, n. 2, p. 6–18, 2010. https://doi.org/10.1002/joe.20304

GUPTA, M.; HOLLADAY, H.; MAHONEY, M. The human factor in JIT implementation: A case study of Ambrake Corporation. **Production and Inventory Management Journal**, v. 41, n. 4, p. 29-33, 2000.

HADID, W.; MANSOURI, S. A. The lean-performance relationship in services: a theoretical model. **International Journal of Operations & Production Management**, v. 34, n. 6, p. 750-785, 2014.

HAIR, J.F., et al. Partial least squares structural equation modeling (PLS-SEM) An emerging tool in business research. **European business review**, v. 26, n. 2, p. 106-121, 2014.

HAIR, J. F., BLACK, W.C., BABIN, B.J., ANDERSON, R.E. **Multivariate data analysis**, 8th ed. Cengage Learning, Hampshire, 2019.

HAIR JR, Joseph F. et al. **Partial least squares structural equation modeling (PLS-SEM) using R**: A workbook. Springer Nature, 2021.

HALEEM, A., SUSHIL, QADRI, M.A., KUMAR, S. Analysis of critical success factors of world-class manufacturing practices: An application of interpretative structural modelling and interpretative ranking process. **Prod. Plan. Control.** n. 23, p. 722–734. 2012. https://doi.org/10.1080/09537287.2011.642134

HANSON, R.K. **Prediction statistics for psychological assessment**. American Psychological Association, Washington, DC, 2022.

HELMS, M.M.; THIBADOUX, G.M.; HAYNES, P.J.; PAULEY, P. Meeting the human resource challenges of JIT through management development. **J. Manag. Dev.** v. 9, n.28, 1990.

HENARD, D. H.; MCFADYEN, M. A. Resource dedication and new product performance: A resource-based view. **Journal of Product Innovation Management**, v. 29, n. 2, p. 193-204, 2012.

Henseler, J. **Composite-based Structural Equation Modeling: Analyzing Latent and Emergent Variables**. Guildford Press, New York.2021.

HERNANDEZ-MATIAS, J.C., OCAMPO, J.R., HIDALGO, A., VIZAN, A. Lean manufacturing and operational performance: Interrelationships between human-related lean practices. **Journal of Manufacturing Technology Management**, v. 31, n. 2, p. 217–235, 2020. https://doi.org/10.1108/JMTM-04-2019-0140

HOYRUP, S., "Employee-driven innovation: a new phenomenon, concept and mode of innovation", in Hoyrup, S., Bonnafous-Boucher, M., Hasse, C., Lotz, M. and Moller, K. (Eds), **Employee-Driven Innovation**: A New Approach, Palgrave Macmillan, New York, NY, pp. 3-33, 2012.

HUO, M. L.; BOXALL, P. Are all aspects of lean production bad for workers? An analysis of how problem-solving demands affect employee well-being. **Human Resource Management Journal**, v. 28, n. 4, p. 569–584, 2018. https://doi.org/10.1111/1748-8583.12204

JACA, Carmen et al. Lean thinking with improvement teams in retail distribution: a case study. **Total Quality Management & Business Excellence**, v. 23, n. 3-4, p. 449-465, 2012.

JANOSKI, T.; LEPADATU, D. **Framing and managing lean organizations**. London: Routledge, 2019.

JAYAMAHA, N. P. et al. Testing a theoretical model underlying the 'Toyota Way'–an empirical study involving a large global sample of Toyota facilities. **International Journal of Production Research**, v. 52, n. 14, p. 4332-4350, 2014.

JING, S., LI, R., NIU, Z., YAN, J. The application of dynamic game theory to participant's interaction mechanisms in lean management. **Computers and Industrial Engineering**, v. 139, n. November 2019, p. 106196, 2020. https://doi.org/10.1016/j.cie.2019.106196

JÜRGENS, U.; KRZYWDZINSKI, M. Breaking off from local bounds: human resource management practices of national players in the BRIC countries. **International Journal of Automotive Technology and Management**, v. 13, n. 2, p. 114-133, 2013. https://doi.org/10.1504/IJATM.2013.052996

KARLSSON, C., ÅHLSTRÖM, P. Assessing changes towards lean production. **Int. J. Oper. Prod. Manag**. v. 16, p. 24–41, 1996. https://doi.org/10.1108/01443579610109820

KAUPPI, K., LUZZINI, D.. Measuring institutional pressures in a supply chain context: scale development and testing. **Supply Chain Manag**. V. 27, p. 79–107, 2022. https://doi.org/10.1108/SCM-04-2021-0169

KERAMIDA, E., PSOMAS, E.L., ANTONY, J. Critical success factors of lean in the public services sector: the case of the Greek citizen's service centers. **TQM J.** 2022. https://doi.org/10.1108/TQM-09-2022-0287

KIM, D.O., BAE, J. Workplace innovation, employment relations and HRM: Two electronics companies in South Korea. **Int. J. Hum. Resour. Manag.** v.16, p. 1277–1302, 2005. https://doi.org/10.1080/09585190500144228

KLEIN, L.L., VIEIRA, K.M., MARÇAL, D.R., PEREIRA, J.R.L. Lean management practices perception and their influence on organizational performance in a public Higher Education Institution. **TQM J.** v.11, 2022. https://doi.org/10.1108/TQM-11-2021-0311

KOEMTZI, Maria D. et al. Lean manufacturing and human resources: a systematic literature review on future research suggestions. **Total Quality Management & Business Excellence**, v. 34, n. 3-4, p. 468-495, 2023.

KRAAIJENBRINK, J.; SPENDER, J.-C.; GROEN, A. J. The resource-based view: a review and assessment of its critiques. **Journal of management**, v. 36, n. 1, p. 349-372, 2010.

KUCKERTZ, A. et al. Startups in times of crisis–A rapid response to the COVID-19 pandemic. **Journal of Business Venturing Insights**, v. 13, p. 100-169, 2020.

KUMAR, N., MATHIYAZHAGAN, K. Sustainability in lean manufacturing: A systematic literature review. **Int. J. Bus. Excell**. v.20, p. 295–321, 2020. https://doi.org/10.1504/IJBEX.2020.106383

KUMAR, Naveen et al. Lean manufacturing techniques and its implementation: A review. **Materials Today: Proceedings**, v. 64, p. 1188-1192, 2022.

KUSRINI, E.; NISA, F.; HELIA, V. N. Lean Service Approach for Consulting Services Company. **International Journal of Integrated Engineering**, v. 11, n. 5, p. 189-195, 2019. https://doi.org/10.30880/ijie.2019.11.05.024

LAMBERT, L.S., NEWMAN, D.A., 2022. Construct Development and Validation in Three Practical Steps: Recommendations for Reviewers, Editors, and Authors*. Organ. Res. Methods 1–34. https://doi.org/10.1177/10944281221115374

LANDER, E.; LIKER, J. K. The Toyota Production System and art: making highly customized and creative products the Toyota way. **International Journal of Production Research**, v. 45, n. 16, p. 3681-3698, 2007.

Lastra, F., Meneses, N., Altamirano, E., Raymundo, C. and Moguerza, J.M. Production management model based on lean manufacturing for cost reduction in the timber sector in Peru, **Advances in Intelligent Systems and Computing**, Vol. 971, pp. 467–476, 2019. doi: 10.1007/978-3-030-20494-5_44.

LIKER, J. **O Modelo Toyota: 14 princípios de gestão do maior fabricante do mundo**. Porto Alegre: Bookman, 2005.

LIKER, J.; BALLÉ, M. Lean managers must be teachers. **Journal of Enterprise Transformation**, v. 3, n. 1, p. 16-32, 2013. https://doi.org/10.1080/19488289.2013.784222

LODGAARD, E., INGVALDSEN, J.A., GAMME, I., ASCHEHOUG, S. Barriers to lean implementation: perceptions of top managers, middle managers and workers. **Procedia CIRP**, v. 57, p. 595-600, 2016. https://doi.org/10.1016/j.procir.2016.11.103

LOPES, N.R.; GODINHO FILHO, M.; GANGA, G.M.D.; TORTORELLA, G.L.; CALLEFI, M.H.B.M.; LIMA, B.T. de. Critical factors for sustaining Lean Manufacturing in the long term: a multimethod study. **Eur. J. Ind. Eng**. v. 17, n. 60, 2023. https://doi.org/10.1504/EJIE.2023.10045201

LYTTON, W.W.; OMURTAG, A.; NEYMOTIN, S.A.; HINES, M.L. Just-in-time connectivity for large spiking networks. **Neural Comput.** 2008, 20, 2745–2756.

LUSE, A., BURKMAN, J. Learned helplessness attributional scale (LHAS): Development and validation of an attributional style measure. **J. Bus. Res**. v.151, p. 623–634, 2022. https://doi.org/10.1016/j.jbusres.2022.07.001

MACKENZIE, S.B., PODSAKOFF, P.M., PODSAKOFF, N.P., MACKENZIE, S.B., 2011. **Construct Measurement and Validation Procedures in MIS and Behavioral Research**: Integrating New and Existing Techniques 35, 293–334.

MALIK, M., ABDALLAH, S. The relationship between organizational attitude and lean practices: an organizational sense-making perspective. **Ind. Manag. Data Syst**. v.120, p.1715–1731, 2020. https://doi.org/10.1108/IMDS-09-2019-0460

MARIN-GARCIA, J. A.; BONAVIA, T. Relationship between employee involvement and lean manufacturing and its effect on performance in a rigid continuous process industry. **International Journal of Production Research**, v. 53, n. 11, p. 3260-3275, 2015. https://doi.org/10.1080/00207543.2014.975852

MARKSBERRY, P., CHURCH, J., SCHMIDT, M. The employee suggestion system: A new approach using latent semantic analysis. **Hum. Factors Ergon. Manuf.** v. 24, p. 29–39, 2014. https://doi.org/10.1002/hfm.20351

MARTINEZ-JURADO, P.J., MOYANO-FUENTES, J., JEREZ-GOMEZ, P., MARTÍNEZ-JURADO, P.J., MOYANO-FUENTES, J., JEREZ-GÓMEZ, P. Human resource management in lean production adoption and implementation processes: Success factors in the aeronautics industry. **BRQ Bus. Res. Q**. v. 17, p. 47–68, 2014. https://doi.org/10.1016/j.cede.2013.06.004

MATHIYAZHAGAN, K., GNANAVELBABU, A., KUMAR.N, N., AGARWAL, V.

A framework for implementing sustainable lean manufacturing in the electrical and electronics component manufacturing industry: An emerging economies country perspective. **J. Clean. Prod.** v.334, 2022. https://doi.org/10.1016/j.jclepro.2021.130169

MATHIYAZHAGAN, K., GOVINDAN, K., NOORULHAQ, A., GENG, Y. An ISM approach for the barrier analysis in implementing green supply chain management. **J. Clean. Prod**. v. 47, p. 283–297, 2013. https://doi.org/10.1016/j.jclepro.2012.10.042

MATHUR, Mahima; KAPOOR, Tamanna; SWAMI, Sanjeev. **Readiness for organizational change: the effects of individual and organizational factors**. Journal of Advances in Management Research, 2023.

MAWARE, Catherine; PARSLEY, David M. The challenges of lean transformation and implementation in the manufacturing sector. **Sustainability**, v. 14, n. 10, p. 6287, 2022.

MCBAIN, R. The practice of engagement: Research into current employee engagement practice. **Strategic HR review**, 2007. https://doi.org/10.1108/14754390780001011

MCLACHLIN, R. Management initiatives and just-in-time manufacturing. **Journal of Operations Management**, v. 15, n. 4, p. 271-292, 1997. https://doi.org/10.1016/S0272-6963(97)00010-7

MCLEAN, R. S.; ANTONY, J.; DAHLGAARD, J. J. Failure of Continuous Improvement initiatives in manufacturing environments: a systematic review of the evidence. **Total Quality Management and Business Excellence**, v. 28, n. 3–4, p. 219–237, 2017. https://doi.org/10.1080/14783363.2015.1063414

MCSHANE, S.; GLINOW, M. A. V. Organizational behavior. **McGraw-Hill Education**. 2017

MEDEIROS, Nayara Cardoso de. **Análise das variáveis contingenciais nas adaptações das práticas de produção enxuta na implementação de sistemas de produção específicos (XPS).** 2016. 129 f. Dissertação (Mestrado em Engenharia de Produção) - Universidade Federal da Paraíba, João Pessoa, 2016.

MEDEIROS, N.C. De, GODINHO FILHO, M., CALLEFI, M.H.B.M. and GANGA, G.M.D. Employee involvement practices in lean manufacturing: a multi-method approach, **International Journal of Services and Operations Management**, Vol. 1 No. 1, p. 1, 2023. doi: 10.1504/IJSOM.2023.10054612.

MEIRINHOS, Galvão et al. Employee involvement and commitment in internal communication. **Social Sciences**, v. 11, n. 9, p. 423, 2022.

MENOR, L. J.; ROTH, A. V. New service development competence in retail banking: Construct development and measurement validation. **Journal of operations management**, v. 25, n. 4, p. 825-846, 2007.

MOHER, D., LIBERATI, A., TETZLAFF, J., ALTMAN, D.G., ALTMAN, D., ANTES, G., ATKINS, D., BARBOUR, V., BARROWMAN, N., BERLIN, J.A., CLARK, J., CLARKE, M., COOK, D., D'AMICO, R., DEEKS, J.J., DEVEREAUX, P.J.,

DICKERSIN, K., EGGER, M., ERNST, E., GØTZSCHE, P.C., GRIMSHAW, J., GUYATT, G., HIGGINS, J., IOANNIDIS, J.P.A., KLEIJNEN, J., LANG, T., MAGRINI, N., MCNAMEE, D., MOJA, L., MULROW, C., NAPOLI, M., OXMAN, A., PHAM, B., RENNIE, D., SAMPSON, M., SCHULZ, K.F., SHEKELLE, P.G., TOVEY, D., TUGWELL, P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. **Annals of internal medicine**, v. 151, n. 4, p. 264-269, 2009. https://doi.org/10.7326/0003-4819-151-4-200908180-00135

MOICA, S., GHERENDI, A., VERES, C., MOICA, T. The Integration of the Blended Learning Concept into Employee Training as a Factor in Shifting Mentalities towards the Industry 4.0 Approach, in: Proceedings of 2019 8th International Conference on Industrial Technology and Management, ICITM 2019. **IEEE**, p. 236–240, 2019. https://doi.org/10.1109/ICITM.2019.8710705

MONDEN, Y. The relationship between mini profit-center and JIT system. **Int. J. Prod. Econ.** 80, 145–154, 2002.

MONDEN, Y. **Sistema Toyota de produção: uma abordagem integrada ao just-in-time**. 4.ed. Porto Alegre: Bookman, 2015.

Moran, J.W. and Brightman, B.K. Leading organizational change", Journal of Workplace Learning, Vol. 12 No. 2, pp. 66–74, 2000. doi: 10.1108/13665620010316226.

MOSTAFA, S., DUMRAK, J.; SOLTAN, H., "A framework for lean manufacturing implementation", **Production & Manufacturing Research**, Vol. 1 No. 1, pp. 44-64, 2015.

Mota, R. de O., Godinho Filho, M., Osiro, L., Ganga, G.M.D. and Mendes, G.H. de S. Unveiling the relationship between drivers and capabilities for reduced time-to-market in start-ups: A multi-method approach, International Journal of Production Economics, Vol. 233, p. 108018, 2021. doi: 10.1016/j.ijpe.2020.108018.

Mothersell, W.M., Moore, M.L. and Reinerth, M.W., Hoshin Kanri planning: The system of five alignments behind the Toyota Production System, **International Journal of Business Innovation and Research**, Vol. 2 No. 4, pp. 381–401, 2008. doi: 10.1504/IJBIR.2008.018587.

MURUGANANTHAM, G. et al. Application of interpretive structural modelling for analysing barriers to total quality management practices implementation in the automotive sector. **Total Quality Management & Business Excellence**, v. 29, n. 5-6, p. 524-545, 2018.

NARAYANAN, S., VICKERY, S.K., NICOLAE, M.L., CASTEL, M.J., MCLEOD, M.K., 2022. The effects of lean implementation on hospital financial performance. **Decis. Sci**. v. 53, p. 557–577. https://doi.org/10.1111/deci.12510

NAWANIR, G., FERNANDO, Y., LIM, K.T. The complementarity of lean manufacturing practices with importance-performance analysis: How does it leverage inventory performance? **Int. J. Serv. Oper. Manag**. v. 39, p. 212–234, 2021. https://doi.org/10.1504/IJSOM.2021.115451

NEGRÃO, L. L. L; GODINHO FILHO, M.; M., G. Lean practices and their effect on performance: a literature review. **Production Planning & Control**, v. 28, n. 1, p. 33-56, 2017. http://dx.doi.org/10.1080/09537287.2016.1231853

NEGRÃO, L. L. L.; LOPES DE SOUSA JABBOUR, A. B., LATAN, H., GODINHO FILHO, M., CHIAPPETTA JABBOUR, C. J.; GANGA, G. M. D. Lean manufacturing and business performance: testing the S-curve theory. **Production Planning & Control**, v. 31, n. 10, p. 771-785, 2020. https://doi.org/10.1080/09537287.2019.1683775

NEIROTTI, P. Work intensification and employee involvement in lean production: new light on a classic dilemma. **International Journal of Human Resource Management**, v. 31, n. 15, p. 1958–1983, 2020. https://doi.org/10.1080/09585192.2018.1424016

NETEMEYER, R., BEARDEN, W., SHARMA. **Scaling Procedures**, Sage Publi. ed. California, 2003.

NGUYEN, A.T., PARKER, L., BRENNAN, L., LOCKREY, S. A consumer definition of eco-friendly packaging. **J. Clean. Prod**. v.252, 2020. https://doi.org/10.1016/j.jclepro.2019.119792

NGUYEN, C.A., ARTIS, A.B., PLANK, R.E., SOLOMON, P.J. Dimensions of effective sales coaching: scale development and validation. **J. Pers. Sell. Sales Manag**. 39, 299–315., 2019. https://doi.org/10.1080/08853134.2019.1621758

NORDIN, N., Md DEROS, B., WAHAB, D.A. and MOHD, M.N. A framework for organisational change management in lean manufacturing implementation, International Journal of Services and Operations Management, Vol. 12 No. 1, pp. 101–117, 2012. doi: 10.1504/IJSOM.2012.046676.

OHNO, T. **O Sistema Toyota de Produção: além da produção em larga escala**. Porto Alegre: Bookman, 1997

OLIVER, N. Human Factors in the Implementation of Just-In-Time Production. **Int. J. Oper. Prod. Manag**. v.10, p. 32–40, 1990.

ONOFREI, G., PRESTER, J., FYNES, B., HUMPHREYS, P. AND WIENGARTEN, F. The relationship between investments in lean practices and operational performance: Exploring the moderating effects of operational intellectual capital, **International Journal of Operations & Production Management**, Vol. 39 No. 3, pp. 406-428, 2019 https://doi.org/10.1108/IJOPM-04-2018-0201

OTHMAN, A. A. E.; KHALIL, M. H. M. A lean talent management framework for maximizing creativity in architectural design firms. **International Journal of Construction Management**, v. 20, n. 5, p. 520–533, 2020.

PAKDIL, F.; LEONARD, K. M. Implementing and sustaining lean process: the dilemma of societal culture effects. **International Journal of Production Research,** 2017. https://doi.org/10.1080/00207543.2016.1200761

PARK, K.C. Exploring the effects of lean practices and supply chain disruption on performance. **Int. J. Serv. Oper. Manag.** v. 43, p. 88–108, 2022. https://doi.org/10.1504/ijsom.2022.126247

PEREIRA, M. et al. The gamification as a tool to increase employee skills through interactives work instructions training. **Procedia computer science**, v. 138, p. 630-637, 2018. https://doi.org/10.1016/j.procs.2018.10.084

PEREIRA, R.; LIKER, J. Using Technology to Enhance PD Performance: A Comparative Case Study 3-D Scanning Technology Deployment. **EMJ - Engineering Management Journal**, 2021. https://doi.org/10.1080/10429247.2020.1779015

POWER, D.; SOHAL, A. S. Human resource management strategies and practices in just-in-time environments: Australian case study evidence. **Technovation**, v. 20, n. 7, p. 373-387, 2000. https://doi.org/10.1016/S0166-4972(99)00151-0

POWER, D.; SOHAL, A.S. An empirical study of human resource management strategies and practices in Australian just-in-time environments. **Int. J. Oper. Prod. Manag**. v.20, p.932–958, 2000.

POWER, D.J.; SOHAL, A.S. An examination of the literature relating to issues affecting the human variable in just-in-time environments. **Technovation**, v.17, p. 649–666, 1997. https://doi.org/10.1016/S0166-4972(97)00071-0

PRASAD, S. et al. Interdependency analysis of lean manufacturing practices in case of Bulgarian SMEs: interpretive structural modelling and interpretive ranking modelling approach. **International Journal of Lean Six Sigma**, 2020.

PUVANASVARAN, P. et al. The roles of communication process for an effective lean manufacturing implementation. **Journal of Industrial Engineering and Management**, v. 2, n. 1, p. 128–152, 2009. https://doi.org/10.3926/jiem.2009.v2n1.p128-152

QURESHI, K.M., MEWADA, B.G., ALGHAMDI, S.Y., ALMAKAYEEL, N., QURESHI, M.R.N., MANSOUR, M. Accomplishing Sustainability in Manufacturing System for Small and Medium-Sized Enterprises (SMEs) through Lean Implementation. **Sustain.** n.14, 2022. https://doi.org/10.3390/su14159732

RACHMAN, A., RATNAYAKE, R.M.C. Adoption and implementation potential of the lean concept in the petroleum industry: state-of-the-art. **Int. J. Lean Six Sigma**. n.10, p. 311–338, 2019. https://doi.org/10.1108/IJLSS-10-2016-0065

RANE, A. B.; SUNNAPWAR, V. K.; RANE, S. Strategies to overcome the HR barriers in successful lean implementation. **International Journal Procurement Management.** v. 9. n. 2, 2016. https://doi.org/10.1504/IJPM.2016.075266

RICHARDSON, M., DANFORD, A., STEWART, P., PULIGNANO, V. Employee participation and involvement: Experiences of aerospace and automobile workers in the UK and Italy. **Eur. J. Ind. Relations.** n.16, p. 21–37, 2010. https://doi.org/10.1177/0959680109355309

RICHARDSON, M., DANFORD, A., STEWART, P., PULIGNANO, V. Employee participation and involvement: Experiences of aerospace and automobile workers in the UK and Italy. **European Journal of Industrial Relations**, v. 16, n. 1, p. 21-37, 2010. https://doi.org/10.1177/0959680109355309

RICHBELL, S. Trends and emerging values in human resource management-The UK scene. **International Journal of Manpower**, 2001. https://doi.org/10.1108/01437720110398356

RINGLE, C.; DA SILVA, D.; BIDO, D. Structural equation modeling with the SmartPLS. Bido, D., da Silva, D., & Ringle, C. **Structural Equation Modeling with the Smartpls. Brazilian Journal Of Marketing**, v. 13, n. 2, 2015.

RISHER, H. "Addin merit to pay for performance", **Compensation & Benefits Review**, Vol. 40, pp. 22-29, 2008.

ROSLIN, E.N., AHMED, S., AHAMAT, M.A., BAHROM, M.Z., IBRAHIM, N. The impact of employee involvement and empowerment in Lean Manufacturing System implementation towards organizational performances. **International Journal on Advanced Science, Engineering and Information Technology**, v. 9, n. 1, p. 188–193, 2019. https://doi.org/10.18517/ijaseit.9.1.7116

ROSSITER, J.R., 2011. Measurement for the social sciences: The C-OAR-SE method and why it must replace psychometrics. **Spinger**, New York, 2011.

ROTHSTEIN, J. S. Contextualizing work: the influence of workplace history and perceptions of the future on lean production at three GM plants. **Critical Sociology**, v. 42, n. 7-8, p. 1143-1161, 2016. https://doi.org/10.1177/0896920515580176

RUPASINGHE, H.D., WIJETHILAKE, C. The impact of leanness on supply chain sustainability: examining the role of sustainability control systems. **Corp. Gov.** n. 21, p. 410–432, 2020. https://doi.org/10.1108/CG-06-2020-0217

SAURIN, T. A.; FERREIRA, C. F. Avaliação qualitativa da implantação de práticas da produção enxuta: estudo de caso em uma fábrica de máquinas agrícolas. **Gestão & Produção**, v. 15, n. 3, p. 449-462, 2008

SARAGIH, Romat et al. The Relationship between Human Resources Practice, Work-Life Balance, and Employee Engagement: An Empirical Study in Indonesia. **The Journal of Asian Finance, Economics and Business**, v. 8, n. 7, p. 357-364, 2021.

SARTAL, A. VÁZQUEZ, X. H.; LOZANO-LOZANO, L. M. Organizational tools and cultural change in the success of lean transformations: Delving into sequence and rhythm. **IEEE Transactions on Engineering Management**, v. 69, n. 5, p. 2205-2217, 2020.

SHAH, R.; WARD, P. P**. Defining and developing measures of lean production. Journal of Operations Management**, v. 25, n. 4, p. 785-805, 2007.

SHINGO, S**. O Sistema Toyota de Produção: do ponto de vista da Engenharia de Produção**. 2.ed. Porto Alegre: Artmed, 1996.

SHINGO, S. **Sistema de troca rápida de ferramenta**: uma revolução nos sistemas produtivos. Porto Alegre: Bookman, 2000.

SHOKRI, A.; WARING, T. S.; NABHANI, F. Investigating the readiness of people in manufacturing SMEs to embark on Lean Six Sigma projects: An empirical study in the German manufacturing sector. **International Journal of Operations & Production Management**, v. 36, n. 8, p. 850-878, 2016. https://doi.org/10.1108/IJOPM-11-2014-0530

SHUCK, B., JIKK, L.A., THOMAS, G., REIO, J. The employee engagement scale: initial evidence for construct validity and implications for theory and practice. **Hum. Resour. Manage.** v.56, p. 953–977, 2017.

SIGNORETTI, A. Explaining variation in the social performance of lean production: a comparative case study of the role played by workplace unions' framing of the system and institutions. **Industrial Relations Journal**, v. 50, n. 2, p. 126-149, 2019.

SIGNORETTI, A. Overcoming the barriers to the implementation of more efficient productive strategies in small enterprises. **Empl. Relations.** v. 42, p. 149–165, 2020. https://doi.org/10.1108/ER-11-2018-0298

SIGNORETTI, A.; SACCHETTI, S. Lean HRM practices in work integration social enterprises: Moving towards social lean production. Evidence from Italian case studies*. **Annals of Public and Cooperative Economics**, v. 91, n. 4, p. 545–563, 2020. https://doi.org/10.1111/apce.12283

SISSON, J.A. Maturing the lean capability of front-line operations supervisors. **International Journal of Lean Six Sigma**, Vol. 10, n. 1, pp. 2-22, 2019. https://doi.org/10.1108/IJLSS-02-2017-0016

SMITH, A., Ockowski, E., Noble, C.H. and Mackling, R., "New management practices and enterprise training in Australia", **International Journal of Manpower**, Vol. 24 No. 1, pp. 31-49. 2003.

SOETARA, A., MACHFUD, AFFANDI, M.J., MAULANA, A. The design on conceptual model for continuation of Lean Manufacturing (LM) implementation in Indonesia wood processing factory using soft system methodology. **International Journal on Advanced Science, Engineering and Information Technology**, v. 8, n. 4, p. 1302–1306, 2018. https://doi.org/10.18517/ijaseit.8.4.5247

SPEAR, L.C., "The character and servant leadership: ten characteristics of effective, caring leaders", **Journal of Virtues & Leadership**, Vol. 1 No. 1, pp. 25-30. 2010.

STADNICKA, D.; ANTOSZ, K. Continuous improvement practice in large enterprises: Study results. **International Journal for Quality Research**, v. 9, n. 1, p. 9–26, 2015.

STELSON, P., HILLE, J., ESEONU, C., DOOLEN, T. What drives continuous improvement project success in healthcare? **International journal of health care quality assurance**, 2017. https://doi.org/10.1108/IJHCQA-03-2016-0035

STIMEC, Arnaud; GRIMA, François. The impact of implementing continuous improvement upon stress within a Lean production framework. **International Journal of Production Research**, v. 57, n. 5, p. 1590-1605, 2018.

STREUKENS, S; LEROI-WERELDS, S. Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results. **European management journal**, v. 34, n. 6, p. 618-632, 2016.

SUBRAMANIAN, N; SURESH, M.; WILLIAM, A.J. Human-related lean practices for manufacturing SMEs' lean transformation: a systematic literature review. **Nankai Business Review International**, 2023.

TALIB, F. et al. A road map for the implementation of integrated JIT-lean practices in Indian manufacturing industries using the best-worst method approach. **Journal of Industrial and Production Engineering**, v. 00, n. 00, p. 1–17, 2020.

TEZEL, A., KOSKELA, L., TZORTZOPOULOS, P. Implementation of continuous improvement cells: a case study from the civil infrastructure sector in the UK. **Prod. Plan. Control, Production Planning and Control.** v. 34, p. 68–90, 2021. https://doi.org/10.1080/09537287.2021.1885794

THOMÉ, A.M.T., SCAVARDA, L.F., SCAVARDA, A.J. Conducting systematic literature review in operations management. **Prod. Plan. Control.** n. 27, p. 408–420, 2016. https://doi.org/10.1080/09537287.2015.1129464

TORTORELLA, G. L.; FOGLIATTO, F. S. Method for assessing human resources management practices and organizational learning factors in a company under lean manufacturing implementation. **International Journal of Production Research**. Vol. 52, n. 15, p. 4623-4645, 2014.

TRAN, D.T., PHAM, H.T., BUI, V.T. The Effect of Contextual Factors on Resistance to Change in Lean Transformation. **J. Asian Financ. Econ. Bus**. v.7, p. 479–489, 2020. https://doi.org/10.13106/jafeb.2020.vol7.no11.479

TU, Q.; VONDEREMBSE, M.A.; RAGU-NATHAN, T.S.; SHARKEY, T.W., "Absorptive capacity: enhancing the assimilation of time-based manufacturing practices", **Journal of Operations Management**, Vol. 24 No. 5, pp. 692-710, 2006.

TUMI, N. Sadeg; H., Ali Nawari; K., Jamshed. Impact of compensation, job enrichment and enlargement, and training on employee motivation. **Business Perspectives and Research**, v. 10, n. 1, p. 121-139, 2022.

VAN ASSEN, M., DE MAST, J. Visual performance management as a fitness factor for Lean. **Int. J. Prod. Res.** v. 57, p. 285–297, 2019. https://doi.org/10.1080/00207543.2018.1479545

VAN ASSEN, M. F. Training, employee involvement and continuous improvement–the moderating effect of a common improvement method. **Production Planning & Control**, v. 32, n. 2, p. 132-144, 2021. https://doi.org/10.1080/09537287.2020.1716405

VAN DUN, D. H.; ICKS, J. N.; WILDEROM, C. P.M. Values and behaviors of effective lean managers: Mixed-methods exploratory research. **European management journal**, v. 35, n. 2, p. 174-186, 2017.

VICENTE, S., ALVES, A.C., CARVALHO, M.S., COSTA, N. Business sustainability through employees involvement: A case study. **FME Transactions**, v. 43, n. 4, p. 362–369, 2015. https://doi.org/10.5937/fmet1504362V

VILKAS, M., STANKEVICE, I., DUOBIENE, J., RAULECKAS, R. Achieving leanness: The relationship of lean practices with process exploitation and exploration. **Int. J. Serv. Oper. Manag.** n. 38, p. 201–219, 2021. https://doi.org/10.1504/IJSOM.2021.113035

VIVARES-VERGARA, J. A.; SARACHE-CASTRO, W. A.; NARANJO-VALENCIA, J. C. Impact of human resource management on performance in competitive priorities. **International Journal of Operations & Production Management**, 2016.

VO, B.; KONGAR, E.; BARRAZA, M. F.S. Kaizen event approach: a case study in the packaging industry. **International Journal of Productivity and Performance Management**, v. 68, n. 7, p. 1343–1372, 2019. https://doi.org/10.1108/IJPPM-07-2018-0282

VON HAARTMAN, R., BENGTSSON, L., NISS, C. Lean practices and the adoption of digital technologies in production. **Int. J. Serv. Oper. Manag.** n. 40, p. 286–304, 2021. https://doi.org/10.1504/IJSOM.2021.118260

VUKADINOVIC, S. et al. Early management of human factors in lean industrial systems. **Safety Science**, v. 119, n. June 2017, p. 392–398, 2019.

WALTHOFF-BORM, X., CHALMET, L. Behind closed doors: The potential of lean management in safety audit services. **Int. J. Serv. Oper. Manag**. v.19, p. 413–430, 2014. https://doi.org/10.1504/IJSOM.2014.065667

WARFIELD J.W. Developing interconnected matrices in structural modelling. **IEEE Transactions on Systems Men and Cybernetics**, v. 4, n.1, p. 51-81, 1974.

WATTS, L.L., MEDEIROS, K.E., MCINTOSH, T.J., MULHEARN, T.J. Decision biases in the context of ethics: Initial scale development and validation. **Pers. Individ. Dif**. v.153, p. 109-609, 2020. https://doi.org/10.1016/j.paid.2019.109609

WICKRAMASINGHE, D.; WICKRAMASINGHE, V. Differences in organizational factors by lean duration. **Operations Management Research**, v. 4, n. 3-4, p. 111-126, 2011. https://doi.org/10.1007/s12063-011-0055-5

WICKRAMASINGHE, G. L. D. Effects of gender on work-related attitudes: study of lean implemented textile and apparel manufacturing firms. **Journal of the Textile**

Institute, v. 107, n. 7, p. 854–863, 2016. https://doi.org/10.1080/00405000.2015.1061795

WICKRAMASINGHE, G.L.D., WICKRAMASINGHE, V. Implementation of lean production practices and manufacturing performance: The role of lean duration**. J. Manuf. Technol. Manag.** n. 28, p. 531–550, 2017. https://doi.org/10.1108/JMTM-08-2016-0112

WICKRAMASINGHE, V., CHATHURANI, M.N. Effects of continuous improvement in streamlining HRM practices. **Bus. Process Manag. J**. v. 27, p. 883–900, 2020. https://doi.org/10.1108/BPMJ-03-2020-0130

WICKRAMASINGHE, V., WICKRAMASINGHE, G.L.D. Effects of HRM practices, lean production practices and lean duration on performance. **Int. J. Hum. Resour. Manag**. v. 31, p. 1467–1512, 2020. https://doi.org/10.1080/09585192.2017.1407954

WICKRAMASINGHE, V.; WICKRAMASINGHE, G. L. D. Variable pay and job performance of shop-floor workers in lean production. **Journal of Manufacturing Technology Management**, 2016. https://doi.org/10.1108/JMTM-12-2014-0130

WILKINSON, A.; DUNDON, T.; GRUGULIS, I. Information but not consultation: exploring employee involvement in SMEs. **The International Journal of Human Resource Management**, v. 18, n. 7, p. 1279-1297, 2007.

WOMACK, J.; JONES, D., **Lean Thinking**: Banish Waste and Create Wealth in your Corporation, Free Press, London, 2003.

WRIGHT, T. A. et al. Best practice recommendations for scale construction in organizational research: The development and initial validation of the Character Strength Inventory (CSI). **Journal of organizational Behavior**, v. 38, n. 5, p. 615-628, 2017.

YADAV, V., J., R., MITTAL, M. L., PANWAR, A., LYONS, A. C. (2019). The propagation of Lean thinking in SMEs. **Production Planning and Control**, 30(10-12), 854-865.

YAN, R., GONG, X. Peer-to-peer accommodation platform affordance: Scale development and empirical investigation. **J. Bus. Res.** n. 144, p. 922–938, 2022. https://doi.org/10.1016/j.jbusres.2022.02.032

YANG, C.C.; YANG, K.J. An Integrated Model of the Toyota Production System with Total Quality Management and People Factors. **Hum. Factors Ergon**. **Manuf. Serv. Ind.**, 23, 450, 2013.

YUIK, C.J., PERUMAL, P.A., FENG, C.J. Exploring critical success factors for the implementation of lean manufacturing in machinery and equipment SMEs. **Eng. Manag. Prod. Serv.** n.12, p. 77–91, 2020. https://doi.org/10.2478/emj-2020-0029

ZACHARATOS, A. et al. Human resource management in the North American automotive industry: A meta-analytic review. **Personnel Review**, v. 36, n. 2, p. 231-254, 2007.

ZAHRA, S.A.; SAPIENZA, H.J.; DAVIDSSON, P., "Entrepreneurship and dynamic capabilities: a review, model and research agenda", **Journal of Management Studies**, Vol. 43 No. 4, pp. 917-955, 2006.

APPENDIX 1

#	Practice	Item
1	Guarantee that individual's behaviors follow companies' goals (P1)	I consider that my individual goals are aligned with the company's objectives
2		I consider that my individual goals are aligned with the objectives of the following task/activity/process (internal customer view)
3		I frequently participate in meetings to align the objectives of my sector, area of expertise, or process.
4		I agree/I am aware of the results that my managers define for my work.
5		~~I can often achieve the objectives my managers set for my work. (item excluded)~~
6	Making job resources available (P2)	I often have enough time for myself and my team to carry out our lean responsibilities
7		~~I often have access to a dedicated meeting room and dedicated spaces for teams to post communications~~
8		~~I agree that my company seeks to use top talent in lean efforts. In addition, participation is always encouraged but not required~~
9		I often have technology resources my company provides to use in lean implementation/efforts
10		I am often assigned to staff based on my ability, training and expertise according to the project
11		I often have the autonomy to prioritize lean actions and activities without operational pressure to return to daily tasks and commitments
12	Promote employee-friendly policies (P3)	I am often proud to work with and produce my company's products
13		I agree that my company provides me with a balance between my work activities and my personal life;
14		I often feel satisfied with my company's compensation system
15		I agree that my company cares about my well-being, health and safety
16	Management support (P4)	I often have support from my managers in carrying out improvement tasks
17		I agree that in my company, senior managers allocate financial and non-financial resources (such as time) to lean efforts
18		I can often rely on my senior managers, who always assist us when we have problems
19		I often feel that top managers rely on self- directed work teams, developing our skills and decision-making power.
20		I often feel that senior managers at my company value my opinions
21	Intensive use of communication and feedback mechanisms (P5)	I can often communicate with anyone in the company, whether from another area, process or department
22		I often participate in informal conversations with my managers about issues and improvement initiatives.
23		I frequently communicate formally (in meetings and emails) with my managers about issues and improvement initiatives.
24		I often participate in informal conversations with my co-workers about issues and improvement initiatives.
25		I frequently communicate formally (in meetings and emails) with my co-workers about issues and improvement initiatives.
26		I frequently receive feedback from my managers about my work
27		I often receive suggestions for improvements about my work from my colleagues
28		I often have information about my performance results (e.g. through Information Systems)
29		I often have information on the performance results of my area or process (for example, through Visual Management Tables)
30		I often use feedback from my managers and/or my colleagues to propose and/or implement improvements

#	Practice	Item
31		I frequently use results information from the Visual Management Framework and/or the Information System to propose and/or implement improvements
32	Education programs, training, and personal development (P6)	I often participate in training programs that provide me with knowledge and self-development
33		I often participate in technical training in lean production.
34		I often attend training to develop teamwork skills (e.g., communication and interpersonal skills)
35		I often participate in training with adequate quality.
36		I often feel safe to engage in lean-centered activities and use my skills to the fullest without fear or reprisal
37	Continuous development of employee's leadership skills (P7)	I am often encouraged to develop leadership skills by my company, which encourages me to use my autonomy on a day-to-day basis
38		I agree that my company is concerned with continuously monitoring employee leadership skills and takes action to improve these skills
39		I often rely on our leaders to challenge existing ways of doing work and share knowledge about different ways of doing work
40		I often believe in my leaders' genuine concern for our workplace and our needs
41	Use of kaizen events (P8)	~~I often participate in kaizen events~~
42		~~I often voluntarily participate in continuous improvement (kaizen) events~~
43		~~I am often encouraged to participate in improvement events to solve complex problems~~
44		I am often motivated/enjoyed to participate in kaizen events
45		I often draw on lessons from previous kaizen events to solve new problems
46		I frequently engage in product and process improvement efforts
47	Use of Reward-based incentives (P9)	I often receive, in addition to fixed compensation (salary and annual raises), rewards with a variable payment that depends on performance, collective effort, professionalism, and flexibility
48		I frequently receive recognition for my achievements and rewards for innovative ideas
49		I am often rewarded for group achievements
50	Provide career advancement opportunities for employees (P10)	I often advance in my career based on merit and performance
51		I often have excellent opportunities to improve my career
52		My company often guides me to develop skills that help me improve and succeed in my career
53	Drive suggestion programs (P11)	I frequently suggest ideas for improvement suggestion programs
54		I frequently make suggestions for product and process improvements
55		I often make suggestions for improving the conditions of the work environment
56	Empowerment (job autonomy) (P12)	I often feel empowered or empowered to make decisions about my work
57		I often have the autonomy to actively contribute to making decisions about my area, process, or department
58		I often have autonomy to use my skills and abilities to perform and/or improve my work
59		My manager often delegates powers to me to make decisions about my work
60		I am often tasked by my manager with making decisions about the area or process in which I work.
61	Promotion of teamwork (P13)	I often get involved in decision-making work teams
62		I often feel satisfied with the achievements achieved by the work team I am part of.
63		I often contribute to the group decision-making process
64		I often contribute to the group decision-making process

#	Practice	Item
65	Multifunctional employee (job rotation) (P14)	I am often trained in more than one area of work
66		I often receive cross-training, ensuring I am not an expert in just one activity
67		I often participate in cross-training to develop multiple skills
68	Encourage innovation and technologies (P15)	I agree that my company uses information technology systems as a source of knowledge to inspire and engage me in lean change
69		I am often involved in activities that use active methodologies as a source of knowledge to inspire me to engage in lean change
70		I agree that my company invests in new technologies, such as comprehensive modeling tools and specialty software, in lean efforts
71		I frequently use collaborative technology with tools and systems designed and made available by my company to facilitate group work in the office and remotely
72		I am often encouraged to use virtual communication tools to facilitate virtual teams in a more assertive decision-making process

APPENDIX 2

CONVITE PARA PARTICIPAÇÃO EM PESQUISA SOBRE ENVOLVIMENTO DOS TRABALHADORES NO *LEAN*

Olá! Tudo bem?

Me chamo Nayara Cardoso e sou estudante de doutorado em Engenharia de Produção na Universidade Federal de São Carlos. Quero convidar vocês para participarem da minha pesquisa sobre o Nível de envolvimento dos trabalhadores em empresas que adotam o Lean (Produção enxuta). Essa pesquisa é importante para entender como o envolvimento entre as pessoas em uma fábrica pode tornar seu emprego mais enriquecedor e satisfatório.

O Questionário apresenta 4 blocos de preenchimento. O primeiro bloco contém itens relativos ao seu envolvimento no trabalho na empresa. O segundo bloco visa registrar sua percepção sobre o seu grau de satisfação no trabalho. O terceiro bloco contém itens sobre o uso de tecnologias na empresa e por fim, o quarto bloco é relativo à caracterização de seu perfil.

Solicitamos gentilmente que responda o questionário a seguir. Não será necessário se identificar. As respostas serão tratadas estatisticamente e de forma agregada. Reforço que não há resposta certa ou errada. Queremos apenas que registre sua impressão sobre o envolvimento entre você e as pessoas que fazem parte do seu trabalho no dia a dia da empresa.

Se tiver alguma dúvida sobre o questionário pode entrar em contato comigo por nayaramedeiros@ufpi.edu.br ou (92)99427-0077.

Você pode levar o questionário para casa e trazer preenchido depois. Nesse sentido, entregue por favor o questionário preenchido para [contato da pessoa na empresa]

Desde já, agradeço pela sua colaboração!

Atenciosamente,

Nayara Cardoso

Bloco 1 – Práticas de Envolvimento dos trabalhadores no Lean

Em relação ao seu envolvimento com as pessoas no dia a dia da empresa, indique o seu nível de concordância, de acordo com a escala a seguir:

Discordo Totalmente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Concordo Totalmente

#	Itens	Escala de Concordância						
1	Eu concordo que em minha empresa os gerentes de alto nível disponibilizam recursos financeiros e não financeiros (como tempo) para esforços *lean*	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2	Eu concordo que minha empresa busca usar os melhores talentos nos esforços *lean*. Além disso, a participação é sempre incentivada, mas não é obrigatória	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3	Eu concordo que minha empresa investe em novas tecnologias, como ferramentas de modelagem abrangentes e softwares especiais, nos esforços enxutos	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4	Eu concordo que minha empresa se preocupa em monitorar continuamente as competências de liderança nos funcionários e toma ações para melhorar essas habilidades	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5	Eu concordo que minha empresa utiliza sistemas de tecnologia da informação como fonte de conhecimento para me inspirar e me engajar em mudanças *lean*	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6	Eu concordo/conheço com os resultados que os meus gestores definem para o meu trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7	Eu considero que as minhas metas individuais estão alinhadas com os objetivos da empresa	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8	Eu considero que as minhas metas individuais estão alinhadas com os objetivos da próxima tarefa/atividade/ processo (visão de cliente interno)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
9	Eu frequentemente confio nos nossos líderes para questionar as formas existentes de fazer o trabalho e compartilhar conhecimento sobre as diferentes formas de fazer o trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10	Eu frequentemente consigo alcançar os objetivos definidos pelos meus gestores em relação ao meu trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
11	Eu frequentemente consigo avançar em minha carreira com base no mérito e no desempenho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
12	Eu frequentemente consigo me comunicar com qualquer pessoa da empresa, seja ela de outra área, processo ou departamento	**1**	**2**	**3**	**4**	**5**	**6**	**7**
13	Eu frequentemente contribuo para o processo de tomada de decisão em grupo	**1**	**2**	**3**	**4**	**5**	**6**	**7**
14	Eu frequentemente disponho de recursos de tecnologia, oferecidos pela minha empresa, para serem utilizados na implementação/esforços enxutos	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15	Eu frequentemente faço sugestões de melhoria para as condições do ambiente de trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
16	Eu frequentemente faço sugestões de melhorias de produtos e processos	**1**	**2**	**3**	**4**	**5**	**6**	**7**

#	Itens	Escala de Concordância						
17	Eu frequentemente me comunico formalmente (reuniões, e-mails) com meus colegas de trabalho sobre problemas e iniciativas de melhoria	**1**	**2**	**3**	**4**	**5**	**6**	**7**
18	Eu frequentemente me comunico formalmente (reuniões, e-mails) com meus gestores sobre problemas e iniciativas de melhoria	**1**	**2**	**3**	**4**	**5**	**6**	**7**
19	Eu frequentemente me engajo em esforços de melhoria de produtos e processos	**1**	**2**	**3**	**4**	**5**	**6**	**7**
20	Eu frequentemente me envolvo em equipes de trabalho para tomada de decisões	**1**	**2**	**3**	**4**	**5**	**6**	**7**
21	Eu frequentemente me motivo/gosto a participar em eventos kaizen	**1**	**2**	**3**	**4**	**5**	**6**	**7**
22	Eu frequentemente me sinto empoderado ou com autonomia para tomar decisões sobre o meu trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
23	Eu frequentemente me sinto satisfeito com conquistas alcançadas pela equipe de trabalho do qual eu faço parte	**1**	**2**	**3**	**4**	**5**	**6**	**7**
24	Eu frequentemente participo de conversas informais com meus colegas de trabalho sobre problemas e iniciativas de melhoria	**1**	**2**	**3**	**4**	**5**	**6**	**7**
25	Eu frequentemente participo de conversas informais com meus gestores sobre problemas e iniciativas de melhoria	**1**	**2**	**3**	**4**	**5**	**6**	**7**
26	Eu frequentemente participo de eventos kaizen	**1**	**2**	**3**	**4**	**5**	**6**	**7**
27	Eu frequentemente participo de programas de treinamento que me proporcionam conhecimento e autodesenvolvimento	**1**	**2**	**3**	**4**	**5**	**6**	**7**
28	Eu frequentemente participo de reuniões para alinhar os objetivos do meu setor, área de atuação ou processo	**1**	**2**	**3**	**4**	**5**	**6**	**7**
29	Eu frequentemente participo de treinamento técnico em produção enxuta	**1**	**2**	**3**	**4**	**5**	**6**	**7**
30	Eu frequentemente participo de treinamentos com qualidade adequada	**1**	**2**	**3**	**4**	**5**	**6**	**7**
31	Eu frequentemente participo de treinamentos cruzados para o desenvolvimento de múltiplas habilidades	**1**	**2**	**3**	**4**	**5**	**6**	**7**
32	Eu frequentemente participo de treinamentos para desenvolver habilidades de trabalho em equipe (por exemplo, comunicação e habilidades interpessoais)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
33	Eu frequentemente participo voluntariamente de eventos de melhoria contínua (kaizen)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
34	Eu frequentemente posso contar com meus gerentes de alto nível, pois estão sempre disponíveis para nos dar assistência quando temos um problema	**1**	**2**	**3**	**4**	**5**	**6**	**7**
35	Eu frequentemente recebo reconhecimento pelas minhas conquistas e recompensas por ideias inovadoras	**1**	**2**	**3**	**4**	**5**	**6**	**7**
36	Eu frequentemente recebo treinamento cruzado o que garante que eu não seja especialista em apenas uma única atividade	**1**	**2**	**3**	**4**	**5**	**6**	**7**
37	Eu frequentemente recebo, além da remuneração fixa (salário e aumentos anuais) recompensas com uma remuneração variável que depende do desempenho, esforço coletivo, profissionalismo e flexibilidade	**1**	**2**	**3**	**4**	**5**	**6**	**7**
38	Eu frequentemente resgato os ensinamentos de eventos kaizen anteriores para resolver novos problemas	**1**	**2**	**3**	**4**	**5**	**6**	**7**

#	Itens	Escala de Concordância						
39	Eu frequentemente sou encorajado a desenvolver competências de liderança pela minha empresa que me incentiva a utilizar minha autonomia no dia a dia	**1**	**2**	**3**	**4**	**5**	**6**	**7**
40	Eu frequentemente sou envolvido em atividades que utilizam metodologias ativas como fonte de conhecimento para me inspirar a me engajar nas mudanças lean	**1**	**2**	**3**	**4**	**5**	**6**	**7**
41	Eu frequentemente sou incentivado a participar de eventos de melhorias para resolver problemas complexos	**1**	**2**	**3**	**4**	**5**	**6**	**7**
42	Eu frequentemente sou orientado pela minha empresa a desenvolver habilidades que me ajudam a aprimorar e alcançar sucesso em minha carreira	**1**	**2**	**3**	**4**	**5**	**6**	**7**
43	Eu frequentemente sou recompensado por conquistas em grupo	**1**	**2**	**3**	**4**	**5**	**6**	**7**
44	Eu frequentemente sou treinado em mais de uma área de trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
45	Eu frequentemente sugiro ideias em programas de sugestões de melhorias	**1**	**2**	**3**	**4**	**5**	**6**	**7**
46	Eu frequentemente tenho acesso a uma sala dedicada para reuniões e espaços dedicados para as equipes postarem comunicações	**1**	**2**	**3**	**4**	**5**	**6**	**7**
47	Eu frequentemente tenho apoio dos meus gestores na realização de tarefas de melhoria	**1**	**2**	**3**	**4**	**5**	**6**	**7**
48	Eu frequentemente tenho autonomia para contribuir ativamente na tomada de decisões sobre minha área, processo ou departamento	**1**	**2**	**3**	**4**	**5**	**6**	**7**
49	Eu frequentemente tenho autonomia para utilizar minhas competências e habilidades para realizar e/ou melhorar o meu trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
50	Eu frequentemente tenho excelentes oportunidades para melhorar minha carreira	**1**	**2**	**3**	**4**	**5**	**6**	**7**
51	Eu frequentemente tenho tempo suficiente para que eu e minha equipe executemos nossas responsabilidades em relação ao lean	**1**	**2**	**3**	**4**	**5**	**6**	**7**
52	Eu frequentemente utilizo tecnologia colaborativa com ferramentas e sistemas projetados, disponibilizados pela minha empresa, para facilitar o trabalho em grupo, tanto no escritório quanto remoto	**1**	**2**	**3**	**4**	**5**	**6**	**7**
53	Frequentemente meu Gerente delega poderes a mim para tomar decisões sobre o meu trabalho	**1**	**2**	**3**	**4**	**5**	**6**	**7**
54	Frequentemente sou encarregado pelo meu gerente de tomar decisões sobre a área ou processo em que atuo	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Bloco 2 – Percepção sobre a Satisfação no Trabalho

Em relação à sua percepção sobre a sua satisfação no trabalho, indique o seu nível de concordância, de acordo com a escala a seguir:

Discordo Totalmente 1 2 3 4 5 6 7 Concordo Totalmente

#	Itens	Escala de Concordância						
1	Minha capacidade de aprendizado por meio da participação em projetos de melhoria aumentou	1	2	3	4	5	6	7
2	Meu envolvimento e sentimento de responsabilidade no trabalho aumentou	1	2	3	4	5	6	7
3	Minha autonomia e capacidade de avaliar meu próprio desempenho, os riscos e erros relacionados ao meu trabalho aumentou	1	2	3	4	5	6	7
4	Meu comprometimento associado às funções e tarefas de meu trabalho aumentou	1	2	3	4	5	6	7
5	Minha satisfação como o meu trabalho como um todo aumentou	1	2	3	4	5	6	7
6	Minha produtividade e eficiência no trabalho aumentou	1	2	3	4	5	6	7
7	Minha capacidade de desempenhar tarefas variadas aumentou	1	2	3	4	5	6	7

Bloco 3 – Percepção do uso de tecnologias

Em relação à sua percepção sobre o uso de tecnologias pela empresa, indique o seu nível de concordância, de acordo com a escala a seguir:

Discordo Totalmente 1 2 3 4 5 6 7 Concordo Totalmente

#	Itens	Escala de Concordância						
1	A empresa vem promovendo esforços para implementar tecnologias nos processos de produção	1	2	3	4	5	6	7
2	Eu me sinto confiante em participar de projetos na empresa envolvendo a implantação de tecnologias no processo em que atuo	1	2	3	4	5	6	7
3	Minha capacidade de usar tecnologias para controlar remotamente instalações e equipamentos aumentou	1	2	3	4	5	6	7
4	Minha capacidade para usar tecnologias como realidade aumentada ou realidade virtual ou outras tecnologias para melhorar eficiência e reduzir erros aumentou	1	2	3	4	5	6	7
5	Minha capacidade de interagir em ambientes homem-máquina (por exemplo, interagir com um robô) ao desempenhar minhas tarefas de trabalho aumentou	1	2	3	4	5	6	7

Bloco 4 – Perfil do Respondente

4.1 Qual o seu nível de instrução?

☐Ensino fundamental ☐Ensino Médio ☐ Ensino Superior ☐Não desejo responder

4.2 Há quanto tempo trabalha na empresa?

☐Menos de um ano ☐Entre 4 e 7 anos ☐Mais de 10 anos
☐Entre 1 e 4 anos ☐ Entre 7 e 10 anos ☐Não desejo responder

4.3 Em que setor atua na empresa?

R: ________________