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# The Implications of Lean Thinking in Digital Transformation Projects

**José Ermeson Silva Carmo[1], José Eduardo de Carvalho Lima[2]**
[1,2] Postgraduate Department of the Paraíso University Center, Juazeiro do Norte, Ceará, Brazil.

**ABSTRACT:** The Internet of Things, Data Science, 3D printing, Artificial Intelligence and Machine Learning are some elements on the agenda related to business modernization. These and other digital technologies promote significant changes in the structures of organizations, from strategic planning to the factory floor. However, this process of Digital Transformation is not only materialized in the implementation of digital technologies in the production chain, but is based on the capacity of these enabled technologies to generate new value propositions. This article proposes a discussion about the implications of Lean Thinking in the implementation of Digital Transformation projects. For this, the study analyzed 21 international academic works, from the year 2018, based on the Web of Science and Scopus repositories. The repositories were selected because they are comprehensive and offer intelligent search tools. After a systematic analysis of the documents, a discussion arose about the central elements capable of expanding the understanding of the components of Lean Thinking and its relationship with Digital Transformation projects.

**KEYWORDS:** Business Strategy, Cultural Change in Organizations, Improved Performance.

## 1. INTRODUCTION

The phenomenon of Digital Transformation has led to significant changes in the operating logic of many organizations. Digital technologies enable new production capabilities as well as new business models (HERBERT, 2017). However, there is growing discussion in the literature about the most appropriate ways to implement such technologies in the production chain. More than simply implementing technologies, Digital Transformation must enable organizations to capture and convert value. In this context, studies have been proposed to assess the impact of Digital Transformation on Lean Production systems (SCHUMACHER; BILDSTEIN; BAUERNHANSL, 2020).

In the context of designing Digital Transformation projects, Keskin (2019) highlights the complexity and level of uncertainty in adopting digital technologies in the production chain. Widely established by Shingo (1981), just-in-time production, continuous improvement, respect for human resources and production flow comprise the pillars of the Lean philosophy, the foundation of post-World War II industry. Later, in 1988, Taiichi Ohno extended this thinking by classifying the types of waste, namely: movements, inventory, transportation, overprocessing, defects, waiting and overproduction (OHNO, 1988).

The authors Womack and Jones (1997) set out the 5 principles of Lean Thinking: Definition of value, Identification of the value chain, Flow of the value chain, pull production and Pursuit of perfection. These elements consist of heuristics that guide competitive production systems. As a complement, digital technologies enable new production capabilities. This thinking sets out the question that guides this discussion: “What are the implications of Lean thinking in Digital Transformation projects?”.

To answer this question, this paper proposes a systematic review of the literature on the Web *of Science* and *Scopus* databases, using Iramuteq to classify the textual corpus.

## 2. LEAN THINKING

The proposition of a Lean philosophy was first elucidated in the work suggested by Womack, Jones and Roos (1990), in their work “The machine that changed the world”, presenting the history of the automobile and its impact on both society and modern production systems, introducing the concept of lean manufacturing in the Toyota Production System and the efficiency gains made possible by the model. A decade earlier, Japanese engineer Shigeo Shingo developed a set of concepts and tools aimed at streamlining manufacturing processes and eliminating waste. Through his work, Shingo defined the key elements of the Lean philosophy: 1) just-in-time production, 2) continuous improvement, 3) respect for human resources and 4) production flow (SHINGO, 1981).

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The author defines the Toyota Production System as an integrated sociotechnical system that organizes production around the flow of material and information (just-in-time production) through the system itself, rather than around the individual technologies of machines, labour and stock. The system thus provides the capacity to deliver high-quality products with minimum waste and maximum efficiency (SHINGO, 1981).

Taiichi Ohno classified seven components as waste: movements, inventory, transportation, overprocessing, defects, waiting and overproduction (OHNO, 1988). The Lean philosophy can be broken down into four strands, namely: Lean Manufacturing, Lean Thinking, Lean Enterprise and Lean PDP (REIS, 2014). The approaches have complementary characteristics. Figure 1 summarizes the strands.

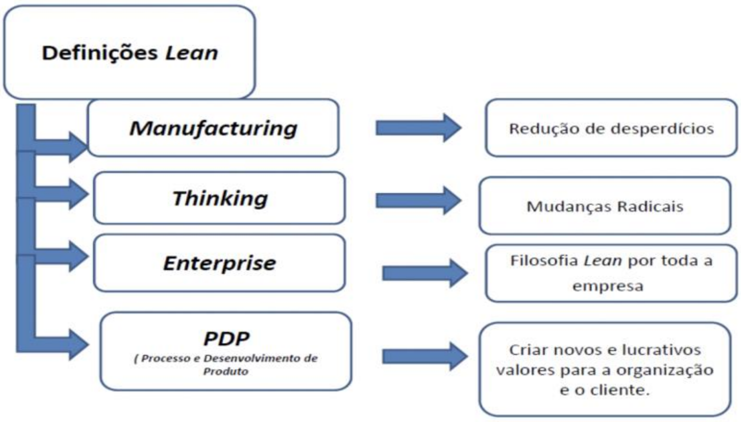


**Figure 1:** Interpretation of the relationship between Lean Manufacturing, Thinking, Enterprise and PDP.
**Source:** Reis (2014)

Lean thinking is capable of promoting a more satisfactory pace of work, providing *feedback* on the workflow and converting waste into value (WOMACK; JONES, 1997). This allows organizations, after specifying value, to be able to align value-creating activities in an optimized sequence, conducting the flow of activities without interruption, autonomously whenever demand is generated. As proposed by Womack and Jones (1997), there are 5 principles of Lean thinking, namely: Definition of value; Identification of the value chain; Flow of the value chain; Pull production; and Pursuit of perfection.

From a human perspective, Liker and Morgan (2006) approach the core of Lean thinking as being people, pointing out that while many organizations seek to reduce dependence on human labor through machines, the Toyota system is designed around people. In this context, people are the heart and soul of the system (LIKER; HOSEUS, 2008).

In the context of services, Lean thinking can be approached as improving the quality of services, reducing waste in the form of waiting times, unnecessary steps and errors, for example. Given its versatility, Lean thinking cannot be analyzed simply as a set of applied tools, but rather as a multidimensional approach that addresses a wide range of management practices based on eliminating waste and continuous improvement (GUPTA, 2016).

## 3. DIGITAL TRANSFORMATION

Digital Transformation is the most prominent type of change in business architecture. Orchestrated by Information Technology (IT), it is capable of enabling new business models while enabling the discovery of new markets, through the operation of three resources: ubiquity of data, unlimited connectivity and high processing power (ROSS; BEATH; MOCKER, 2019).

More than just adopting technologies in the value chain, Digital Transformation evokes significant changes in processes for highly automated business operations, capable of supporting new value propositions, services, products, processes and disruptive systems (ZIMMERMANN; SCHMIDT; JAIN, 2020). Despite the perceived sense of urgency in the face of the ecosystem of constant and rapid change, Digital Transformation projects must be carefully planned, since plans executed quickly, without a perception, maturation and strategic adaptation, can generate disastrous results (GØTZE; ROMANOV, 2021). Thus, Bharadwaj et

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al. (2013), by stating that Digital Transformation is made up of scope, scale and sources, established four elements of interaction between Digital Transformation and business strategy. Table 1 summarizes Bharadwaj et al.'s (2013) vision of the dimensions, issues, and implications for managers regarding Digital Transformation.

**Table 1:** Digital transformation: dimensions, issues and implications for managers

| Dimension of digital transformation | Questions for managers (strategic, organizing, business models) | Key topics |
|---|---|---|
| The scope of digital strategies | • What analytical approaches go beyond the extended firm view? • What are the emerging spaces for value creation? | Defining and analyzing spaces for value creation |
| The scale of digital strategies | • What is the relative importance of platforms? What typology? Which governance structures foster innovation? | Defining and analyzing the new scope of value creation |
| The speed of digital strategies | • How to define and deploy innovative offers? | Analyzing acceleration as a systemic phenomenon |
| The sources of value creation based on digital strategies | • What are sources of value creation in digital spaces? | Defining how value is proposed in digital spaces |

**Source:** Bharadwaj et al. (2013)

In the context of planning, Gupta (2018) proposes a framework for recreating a strategic vision in four key components: (i) reimagining the business, (ii) reassessing the value chain, (iii) reconnecting with customers and (iv) rebuilding the organization.

In the context of projects, Digital Transformation differs from traditional IT projects. The work suggested by Gertzen, Van Der Lingen and Steyn (2022) summarizes some differences from the perspective of multiple authors in Table 2.

**Table 2:** Differences between traditional projects and digital transformation.

| Variable | Traditional project | Digital transformation project | Reference |
|---|---|---|---|
| Effect on the company value proposition | Enable current value proposition | Redefine value proposition | Wessel et al. (2021:8) |
| Effect on the company's identity | Support current identity | (Possibly) change the company's identity | Wessel et al. (2021:8) |
| Relationship to business strategy | Driven by business strategy | Driver of business strategy | Yoo, Henfridsson and Lyytinen (2010:733) |
| Drivers | Incremental performance improvements, a changing cyber-security environment | Market trends, technological changes, paradigm shifts | Horlach, Drews and Schirmer (2016:1421) |
| Focus | Security, reliability, predictability | Innovation, disruption | Horlach et al. (2016:1421) |
| | Exploit existing knowledge, update legacy systems | Agility, speed of delivery, solving new problems | Gartner (2019) |
| | Enhance existing capabilities | Develop new capabilities | Henriette et al. (2015:437) |
| Platforms | Runs on established infrastructure | Experiments with new infrastructure | Horlach et al. (2016:1421) |
| Mode of execution | Traditional, sequential, waterfall methodology | Exploratory, non-linear, agile | Gartner (2019) |

**Source:** Gertzen, Van Der Lingen and Steyn (2022).

Faced with the change in perspective on the strategic horizon, Digital Transformation projects, especially in relation to Industry 4.0, have a complex and uncertain path, which makes it difficult to evaluate and make decisions about project portfolio selection (KESKIN, 2019).

It should be noted that Digital Transformation projects involve considerable risks and, therefore, established organizations must create a culture that encourages risk-taking and favors autonomy (GOBBLE, 2018).

## 4. METHOD

This article seeks to highlight Lean thinking considerations in Digital Transformation projects through a systematic literature review (SLR). The purpose of an SLR is to establish the basis of what has been known about the topic so far and then provide support for more adherent, necessary and ethical research (DRESCH; LACERDA; ANTUNES, 2015). To bring relevant and significant international literature, we opted to search for productions in the English language. The main objective is to answer the question "what are the implications of Lean thinking in Digital Transformation projects?".

Considering the speed of progress in the literature, the research databases used for consultation were *Web of Science* and *Scopus*, using the search keywords in the repositories: *"Lean"* + *"Digital Transformation"* + *"Project"*. The databases used were selected because they are comprehensive and offer intelligent search tools.

The study only included articles published in English, including publications made in the past 5 years (2018 to July 2022). The study materials included academic articles, conference papers and book chapters. Literature review articles were initially discarded from the study. Figure 2 shows the methodological approach.

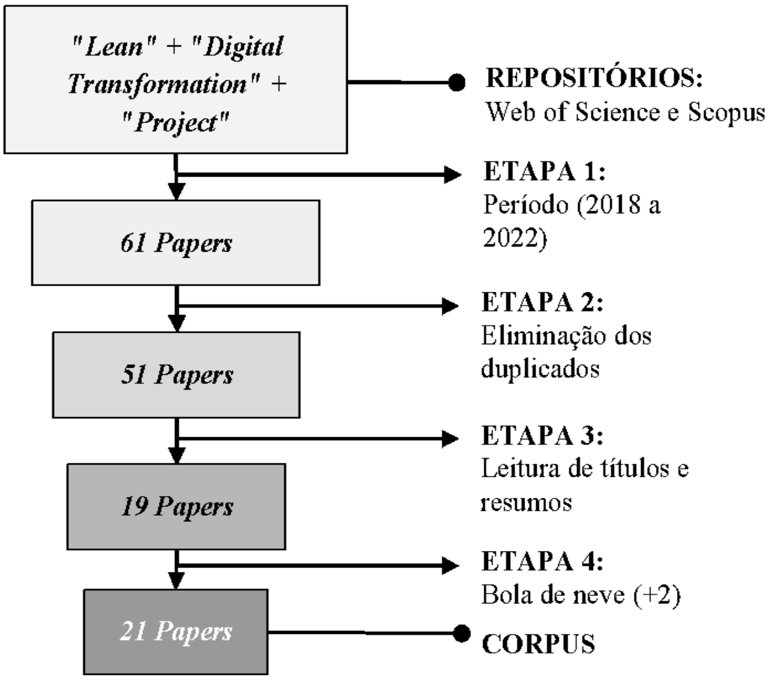


**Figure 2:** Selection of scientific documents that form part of the corpus of analysis
**Source:** Prepared by the authors

After listing the articles provided by the databases, totaling 67 documents, they were cataloged using the *Mendeley* tool. In the first filter (temporal), 6 documents were removed. Next, a filter was applied to eliminate duplicate papers, removing 10 papers from the reference database. After reading the titles, abstracts and keywords of the remaining papers, to ensure relevance and pertinence to the subject studied, 32 papers were eliminated, as they were considered unsuitable for the proposed analysis. After reading the 19 residual documents, 2 papers were added by snowballing. The final corpus of analysis was made up of 21 documents.

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The papers analyzed will be detailed below. An important limitation for this study was the availability of the full documents, i.e., documents that were listed in the databases, but without access to the full document, were not included. A summary of these authors' contributions will be presented in the next section.

## 5. DISCUSSION OF RESULTS

To segment the documents under analysis, a textual corpus was built using the conclusions of the papers selected for the review. In the initial phase of submitting the text corpus, the tool sequenced the batch of articles, giving rise to 181 text segments. The text segments, in turn, generated 6,637 occurrences, i.e., words, propositions, and forms. The result was 1,313 lemmas, i.e., distinct words, and 252 Hapax (words with a single occurrence). In addition, the IRaMuTeQ *software* segmented the documents in the analysis corpus into 5 *clusters*. Figure 3 shows, utilizing a dendrogram, the division of the documents into classes in the textual corpus for analysis, segmenting the most frequently occurring words into these classes.

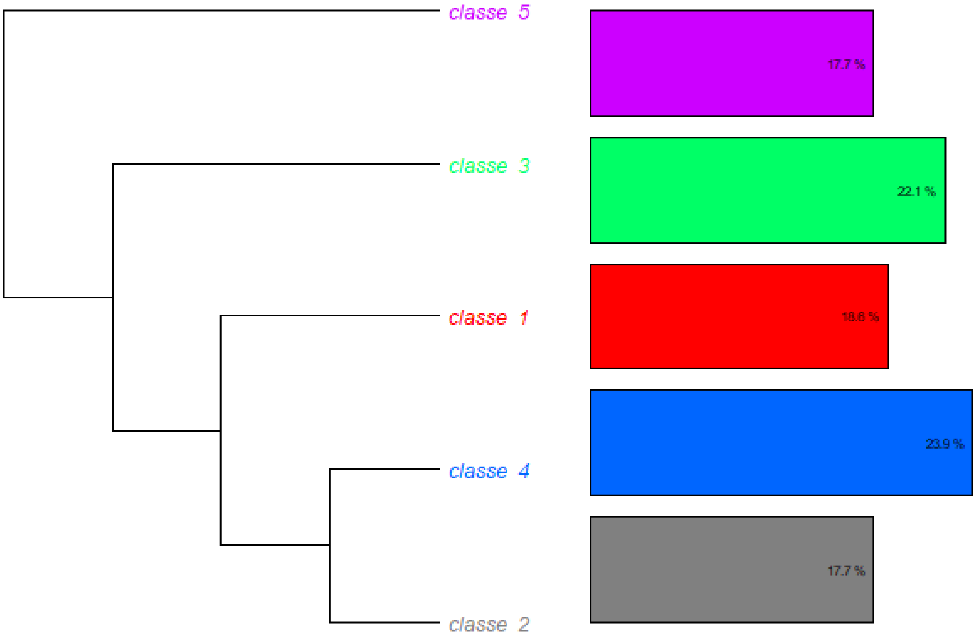


**Figure 3:** Top-down hierarchical classification
**Source:** Prepared by the authors

After analyzing the materials, thematic axes were established for the classes into which the work was segmented (Figure 3). Once the papers had been segmented, the final analysis of the materials began, considering the full documents. Table 3 shows the articles that make up the final corpus of analysis.

**Table 3:** Articles selected for the analysis corpus

| *Authors* | *Titles* |
|---|---|
| Fukuzawa M., Sugie R., Park Y., Shi J. | An Exploratory Case Study on the Metrics and Performance of IoT Investment in Japanese Manufacturing Firms |
| Tantscher D., Mayer B. | Digital Retrofitting of legacy machines: A holistic procedure model for industrial companies |

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| | |
|---|---|
| Frost N. | Change management: Lean digital transformation |
| Rybski C., Jochem R. | Procedure model to integrate digital elements into lean production systems |
| Spaltini M., Sassanelli C., Rossi M., Terzi S., Taisch M. | Using waste as a driver to integrate digital and engineering practices maturity in the product development process: an application case |
| Sengupta S., Dreyer H., Powell D.J. | Breaking Out of the Digitalization Paradox |
| Yordanova Z. | Evolution of Lean Startup over the Years — A Bibliometric Analysis |
| Himmelstoß H., Rapp S., Yesilyurt O., Bildstein A. | Systematic extension of a simulation game for digitalized production |
| Busto Parra B., Pando Cerra P., Álvarez Peñín P.I. | Combining ERP, Lean Philosophy and ICT: An Industry 4.0 Approach in an SME in the Manufacturing Sector in Spain |
| KALINOWSKI, Marcos et al. | Lean R&D: An Agile Research and Development Approach for Digital Transformation |
| Burggräf P., Lorber C., Pyka A., Wagner J., Weißer T. | Kaizen 4.0 Towards an Integrated Framework for the Lean-Industry 4.0 Transformation |
| Ebrahimi M., Baboli A., Rother E. | The evolution of world-class manufacturing towards Industry 4.0: A case study in the automotive industry |
| Alieva, J; Powell, DJ | The significance of employee behaviors and soft management practices to avoid digital waste during a digital transformation |
| Tran, TA; Ruppert, T; Abonyi, J | Indoor Positioning Systems Can Revolutionize Digital Lean |
| Kolla, S; Minufekr, M; Plapper, P | Deriving essential components of lean and industry 4.0 assessment model for manufacturing SMEs |
| Powell, D; Morgan, R; Howe, G | Lean First … then Digitalize: A Standard Approach for Industry 4.0 Implementation in SMEs |

| | |
|---|---|
| Cresnar, R; Potocan, V; Nedelko, Z | Speeding Up the Implementation of Industry 4.0 with Management Tools: Empirical Investigations in Manufacturing Organizations |
| Horvath, D; Szabo, RZ | Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? |
| Buer, SV; Strandhagen, JW; Semini, M; Strandhagen, JO | The digitalization of manufacturing: investigating the impact of production environment and company size |

**Source:** Prepared by the authors

The papers were read and summarized using the Rayyan computer tool, and the contributions of each paper analyzed were systematized using the text categorization tool. The final corpus of analysis was made up of the types of work shown in Figure 4.

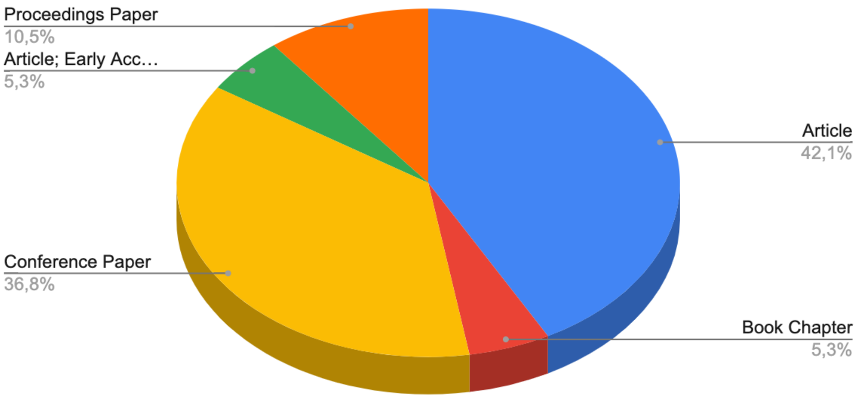


**Figure 4:** Types of work that make up the corpus of analysis
**Source:** Prepared by the authors

In the context of small and medium-sized enterprises (SMEs), a strategic factor in the manufacturing process is agile product innovation. This characteristic can both enable the business to sustain itself and provide input for finding and operating in new markets and business sectors (KOLLA; MINUFEKR; PLAPPER, 2019). The authors establish *assessment* tools by asking what the essential components of a manufacturing SME are to assess its current Lean and Industry 4.0 status. In this way, despite financial constraints and the inability to purchase machinery, these organizations can generate differentials through customized manufacturing (KOLLA; MINUFEKR; PLAPPER, 2019). In contrast to large organizations that combine investment efforts in manufacturing technologies and predictive systems, SMEs use a relationship approach closer to the consumer as a tactic to circumvent market fluctuations. In this sense, tools such as *Value Stream Mapping* (VSM 4.0) help to establish a closer relationship with the customer, since they enable the identification and removal of bottlenecks that can lead to delays in customer service, as well as enabling organizations to identify, visualize and prioritize the value activities that are being carried out to serve their customers. As shown in Table 3, the authors have mapped the components of Lean and Industry 4.0 with the specific characteristics of a manufacturing SME.

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**Table 3:** Mapping the characteristics of manufacturing SMEs with Lean and I4.0 components.

| ***Characteristic of an SME*** | ***Lean and I4.0 components*** |
|---|---|
| Ability to produce customized products | Lean components: Reduction of change over time (SMED); Continuous improvements (kaizen); Production leveling (heijunka).<br>I4.0 components: Simulation models; Smart facilities. |
| Lack of up-to-date ICT integration | I4.0 components: Vertical integration of the company-wide network. For example, Enterprise Resource Planning (ERP) and Collaborative Planning, Forecasting and Replenishment (CPFR). |
| Lack of advanced manufacturing technologies (AMT) | I4.0 components: Machine to machine communication; Human to machine interface. |
| A close relationship with customers | Lean components: Value Stream Mapping (VSM) I4.0 components; Horizontal integration of value networks. For example: ICT infrastructure for scheduling and controlling external logistics |
| Lack of awareness of standards and decentralization of processes, as well as interdepartmental and interdisciplinary collaborations. & Excess storage | Lean components: Material replenishment, VSM, and standardization.<br>I4.0 components: Horizontal and vertical integration of all the sociotechnical systems in the company. |
| Knowledge gap in strategic decision-making | Lean components: Key Performance Indicators (KPIs); Strategic planning and implementation of lean tools.<br>I4.0 components: Big data analytics of decision-making; Strategic planning and implementation of digital tools. |
| Lack of a strong collaborative network | Lean components: Multiple suppliers.<br>I4.0 components; Horizontal integration of value networks. |
| Diverse qualification of employees & lack of mentoring, targeted individual training and supervision | Lean components: Training on lean tools such as 5S, quality and standardization<br>I4.0 components: Training on smart sensors, digital technologies, and data analytics etc. |
| Resistance to change, Lack of open innovation culture & Lack of flexible organizational culture | These specific characteristics hinder the transformation towards lean and I4.0 in a manufacturing SME. Therefore, management needs a long-term holistic transformation plan of above-mentioned dimensions. |

**Source:** Kolla, Minufekr and Plapper (2019)

In terms of operations, SMEs sometimes store too much stock, given their difficulty in having the resources and skills needed to identify market patterns, simulate and decentralize processes (KOLLA; MINUFEKR; PLAPPER, 2019). The lack of financial resources and technical knowledge in manufacturing SMEs is a barrier to implementing Lean methodologies.

For customized production, organizations must be able to offer quick responses to consumer demands. Thus, Kolla, Minufekr and Plapper (2019) state that the adoption of Lean tools, such as Single-Minute Exchange of Dies (SMED), leads to a reduction in setup times, generating gains in flexibility in the value chain. The culture of continuous improvement (Kaizen) promotes the adoption of better manufacturing practices. Finally, through Heijunka, production leveling is made possible. In this way, a combination of these approaches can contribute to the strategic aspect of SMEs regarding the customization production strategy

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(KOLLA; MINUFEKR; PLAPPER, 2019). From a complementary perspective, Buer et al. (2020) state that the size of the organization is a more decisive element in digitalization than the production environment itself. Organizations, especially SMEs, must concentrate their efforts as soon as possible to survive in the future. Considered laggards when it comes to digitizing the shop floor and developing Information Technology (IT) skills, SME managers can initiate digitization plans through smaller pilot projects to familiarize themselves with the possibilities and challenges of emerging technologies with less risk, as well as integrating themselves into shared knowledge networks (BUER et al., 2020).

As business processes throughout the production chain begin to incorporate digital technologies, it is necessary to adopt a management profile capable of dialoguing with this new context (HORVÁTH; SZABÓ, 2019). The authors' contribution deals with the barriers and driving forces in the implementation of Digital Transformation projects, showing that this difficulty becomes more relevant in smaller companies. In addition, Digital Transformation projects that are not planned to have flexible structures that do not support the flow of information tend to fail. In line with Kolla, Minufekr and Plapper (2019), customer satisfaction is the focal point for SMEs, as is the challenge (called a barrier by the authors) of finding employees with the right skills (HORVÁTH; SZABÓ, 2019). In short, the structure of the process, as well as the development of people, must be constantly rethought.

In a complementary way, Tantscher and Mayer (2022) state that this new consumption model, boosted by digital technologies, promotes constant pressure to reduce costs and shorten the production cycles required by customers, while the demand for highly customized products grows. In this context, production flexibility must be sought with the mechanisms made possible by Industry 4.0. The paper also makes contributions to *retrofitting*, establishing it as a key element in an organization's Digital Transformation process. The authors state that Digitalization, in general, together with Digital *Retrofitting* in the production field, is rooted in Lean thinking, since the implementation of Lean mechanisms acts as a preliminary stage for exploiting the effectiveness and efficiency brought about by digital technologies, such as process quality, reducing the complexity of production systems and reducing waste (TANTSCHER; MAYER, 2022). Therefore, to make a digital *retrofit* project efficient, it is important to consider the aspects of lean management in two phases. The first phase is the definition of the use case, making sure that the processes in use are already optimized for Lean production methods. The second phase is in validating the results. In doing so, you need to focus on ensuring that the results are aligned with the concepts and ideas of Lean production. This will ensure that the workflow is efficient and there is little waste. Digital *Retrofitting* can thus represent a promising approach to digitizing legacy production systems (TANTSCHER; MAYER, 2022).

The work by Ebrahimi, Baboli and Rother (2019) highlights the link between the 5 pillars of WCM and the most important elements of the I4.0 principles (Figure 5).

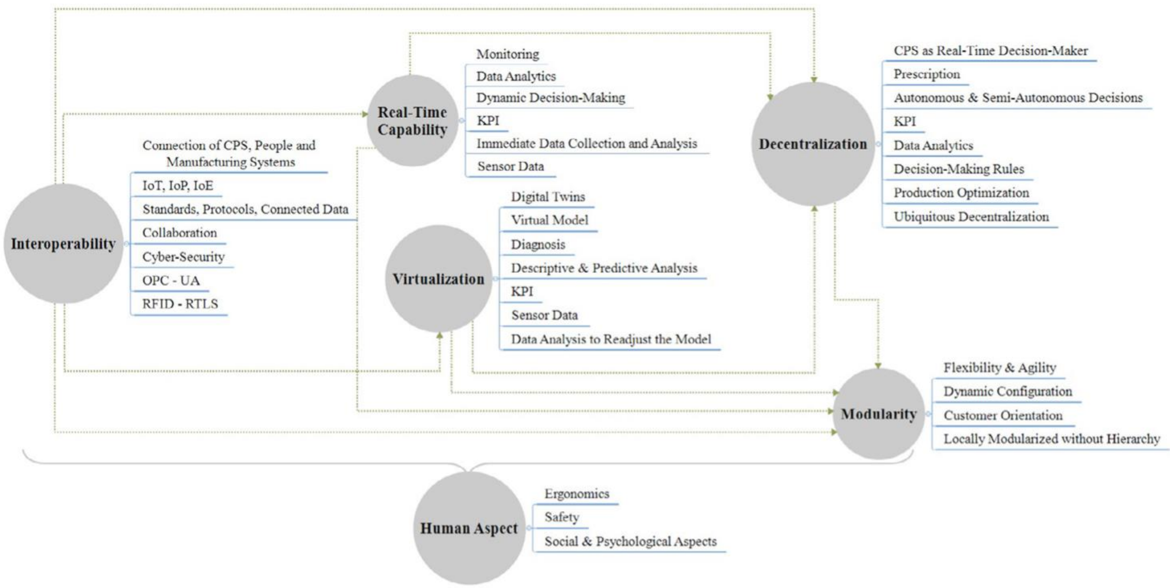


**Figure 5:** Industry 4.0 Design Principles
**Source:** Ebrahimi, Baboli and Rother (2019)

The study highlights that the most significant elements of the I4.0 principles are *Monitoring*, *Digital Twins* (*DT) & Virtual Models* and *Data Analysis* (EBRAHIMI; BABOLI; ROTHER, 2019). These elements are related to the principles of *virtualization*, *real-time capability* and *decentralization*.

The work by Alieva and Powell (2022) identifies 29 soft management practices (Lean and TQM) and employee behaviors under the influence of Digital Transformation. The study contributes to the field of team management by identifying which characteristics of employee behavior need to be analyzed to conduct a Digital Transformation project, guiding them towards soft management practices (Lean and TQM). Above all, the study discusses the impact of Digital Transformation on *soft management* practices and the implications for employee behaviour, providing input in the Lean and TQM fields and highlighting practices that should be prioritized during a Digital Transformation project (ALIEVA; POWELL, 2022).

Motivated by the difficulty of training and investment related to the implementation of a Digital Transformation project, the study proposed by Rybski and Jochem (2020) identified eight central elements, which help to compose a model based on milestones to promote the integration of these identified elements with the existing Lean manufacturing system in organizations. The components are: virtualization (AR/VR), *big data*, sensors/actuators, cloud computing, simulation, additive manufacturing, mobile devices and cybersecurity. Given the components, a model is prescribed for integrating them into the Lean system consisting of 4 phases, illustrated in Figure 5.

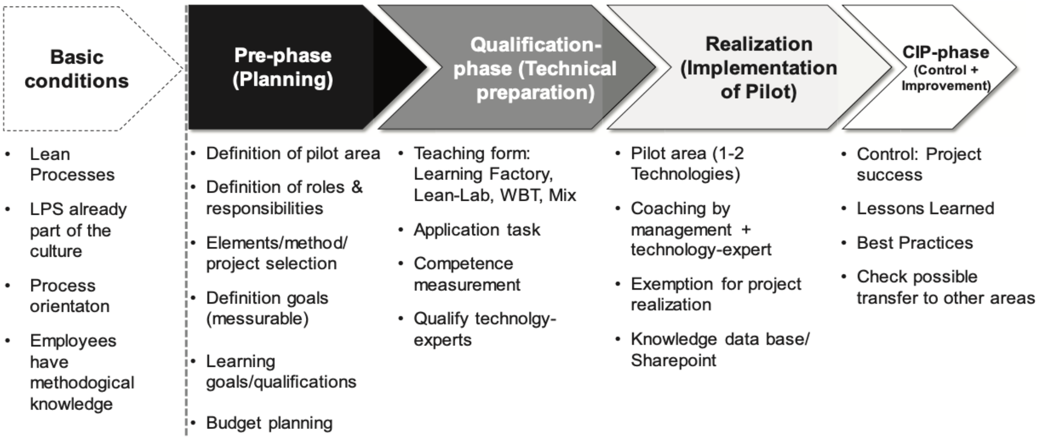


**Figure 5:** Step-by-step process for integrating digital elements into the LPS
**Source:** Rybski and Jochem (2020)

An important consideration regarding the model is the need to initially establish a thorough methodical knowledge of the composition of the *Lean Production System* (RYBSKI; JOCHEM, 2020).

The combination of Lean thinking with digital technologies, through operational technologies and IT tools, can improve real-time visibility of the value stream (TRAN; RUPPERT; ABONYI, 2021). The authors determine that the *Indoor Positioning System* (IPS) makes up one of the most promising IT elements to support operations based on Lean 4.0 and flexible manufacturing systems, given its wireless mobile positioning/tracking capability. In their paper, Tran, Ruppert and Abonyi (2021) propose the development of an IPS-driven *framework* for Lean 4.0, through which it is possible to determine the productivity and efficiency of production systems by collecting and mining data. Flexible and configurable manufacturing poses challenges in terms of dynamic mapping of the value stream, so this proposal consists of a solution based on process mining, which makes it possible to enrich the sources of information for value mapping, thus transforming positioning data into key performance indicators, feeding into Lean Manufacturing (TRAN; RUPPERT; ABONYI, 2021).

In a complementary way, the study suggested by Črešnar, Potočan and Nedelko (2020), clarifies that the use of Six Sigma management tools, TQM, RFID, Balanced Scorecard, Rapid Prototyping, Customer Segmentation, mission, and vision statements for Digital Transformation are positively linked to readiness for Industry 4.0. The study provides information that allows organizations to consider which aspects are most relevant for measuring the implementation of Digital Transformation projects in the context of Industry 4.0. The study also points out which management tools can enhance and/or hinder the implementation of projects based on I4.0. In addition, it highlights the need for management to focus efforts on carrying out activities related to the postulated mission and vision face-to-face with the implementation of Industry 4.0, helping to disseminate strategic planning, which is, at its core, a very similar tool to traditional mission and vision statements, and can play a substantial role in the successful implementation of Industry 4.0 projects. Therefore, in addition to detailed implementation projects, the need for employee training *workshops* stands out. Managers, in possession of this information, need to ensure that strategic goals are realized from the lowest levels in organizations (ČREŠNAR; POTOČAN; NEDELKO, 2020). In addition, the creativity of organizations and their employees in providing appropriate solutions will drive a successful I4.0 project implementation. This can be achieved both through the use of contemporary management tools, such as rapid prototyping, as well as traditional management tools, such as mission statement and project vision can help in the composition of this environment (ČREŠNAR; POTOČAN; NEDELKO, 2020).

## 6. FINAL CONSIDERATIONS

This article discusses the implications of Lean Thinking in the context of Digital Transformation projects. Based on a literature review using the IRaMuTeq tool, it emerged that there is a difference in the approach to Lean Thinking in relation to the size of organizations when it comes to Digital Transformation projects. In a global ecosystem of constant change, there is pressure on the production system for customized production that forces organizations to respond quickly to new and fluctuating consumer demands. Production flexibility can therefore be sought through the mechanisms made possible by Digital Transformation. Digital Transformation projects that are not designed to have flexible structures that do not support the flow of information are likely to fail.

In this way, SMEs can use agile innovation as a strategic factor in manufacturing, given their flexibility, ability to act quickly and proximity to the consumer. Large companies, on the other hand, have a greater capacity to invest in forecasting technologies and thus overcome market fluctuations. In addition, this paper lists, based on the respective authors, the characteristics of SMEs and correlates them with the components of Lean thinking.

It can also be seen that traditional management practices based on Six Sigma, TQM, RFID, Balanced Scorecard, Rapid Prototyping, Customer Segmentation, mission, and vision statements for Digital Transformation are positively linked to readiness for Industry 4.0.

Finally, Lean approaches to Digital Transformation projects must prepare leaders and employees, enabling them not only to use platforms and technologies, but also involving them at all levels in the strategic planning of the Digital Transformation project. In summary, it is safe to say that Lean Thinking can provide the basis for Digital Transformation and Industry 4.0 in a complementary relationship, since Digital Transformation maximizes the efficiency of Lean. It should also be noted that Lean principles are changing, so the structure of the process, as well as the development of people, must be constantly rethought, corroborating the thinking of Shingo (1981) and Ohno (1988) even after 40 years.

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