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Sustaining Continuous Improvement Programs

Proposition of Influential Elements and a Maturity-Benchmark Model

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Abstract

Purpose: The purpose of this article is to shed light on the studies regarding the influential elements that contribute to the sustainability of Continuous Improvement (CI) programs. It aims to define the notion of sustainability and to identify and explore the influential elements that could encompass such a definition.

Design/methodology/approach: A comprehensive literature review was conducted to categorize various interpretations of sustainability into distinct dimensions. This approach also identified 16 influential elements that have the potential to sustain CI programs. A self-assessment survey involving 80 French companies was employed to evaluate these elements through the PDCA framework. Additionally, a maturity-benchmark model is introduced to help evaluate the degree of maturity of the most influential elements of CI programs.

Findings: The results highlight the inherent paradox in sustaining Continuous Improvement (CI) programs, where robustness and adaptability must coexist. The study identifies a relationship between influential elements and organizational maturity levels, offering actionable insights to help companies advance through these stages. Human-centered elements, such as leadership and employee engagement, have the greatest impact on CI sustainability, emphasizing the importance of fostering a people-centric culture. Conversely, operational elements are less influential, suggesting a need for balanced strategies.

Originality: This article discusses a topic that is rarely addressed, namely, how to sustain CI programs within a CI framework. This article provides a novel synthesis of influential elements and their relationships to organizational maturity within a CI framework, challenging traditional static views of sustainability. By emphasizing the dynamic and evolving nature of CI programs, it bridges theory and practice, offering organizations a practical model for continuous reassessment and adaptation.

Keywords – Continuous Improvement, Lean, Deployment, Maturity-Benchmark Model.

Paper type – Research article.

1. Introduction

Continuous improvement (CI) remains a strongly discussed topic in operations management literature. The benefits of CI initiatives have been assessed, sometimes criticized, or compared to disruptive innovation initiatives. Even though disruptive innovation is gaining more interest, efforts to sustain these initiatives are still vibrant in most companies that adopt either CI or disruptive initiatives. CI can also be viewed as a philosophy aimed at systematically improving value (e.g., Lean Manufacturing, Lean Management), while resolving sources of inefficiencies related to the products or services and promoting incremental innovation across all areas of the business. Some authors (Savolainen, 1999; Bhuiyan and Baghel, 2005) argue that no definitive study clearly defines the CI philosophy. They emphasize that CI is a blend of methodologies (e.g., Lean, Six Sigma, TQM) and techniques (e.g., Root Cause Analysis, PDCA) focused on improving quality at various levels. The approach prioritizes the positive evolution of repetitive structured processes, and the relationship with standardized work which can be executed individually or in workgroups. CI is oftentimes visible throughout a series of small changes that experience incremental improvements within operations processes (Duffy, 2013). The accumulation of CI initiatives improves the overall performance in production or engineering systems, mainly by creating a culture that eliminates **arduous tasks**, waste and variability, as well as providing benefits in terms of lead times, productivity, quality, value to customers, and other business dimensions (Soliman and Saurin, 2017). CI initiatives are often linked to competitive advantage, further fueling interest in their adoption (Rich et al., 2006). While such initiatives can yield significant gains over time, companies may be tempted to declare success prematurely after achieving short-term benefits (Mitchell, 2015). While it seems plausible to associate sustainability with positive financial results, it is important to consider other dimensions that contribute to long-term success, such as quality, cycle time, employee skills, and productivity (Bhasin, 2012).

Despite the recognized benefits of CI initiatives (Villarreal et al., 2016), organizations often struggle to sustain these efforts over time (Keating et al., 1999), as companies struggle to sustain the initial benefits or engagement toward efforts (Bessant et al., 1994; Bateman, 2005). One reason for this undesirable decline is that companies regularly focus on operational benefits without ensuring that the necessary procedures and competencies are firmly established within their organization (Mitchell, 2015). Even though companies invest in technology to enhance their process flexibility (Esmailian et al., 2016), CI remains inherently characterized by high levels of uncertainty, complexity and dynamic interactions. These aspects often require management approaches that are compatible with their nature (Soliman and Saurin, 2017) which **make sustaining difficult** CI initiatives. In an industrial context, the concept of sustainability is often poorly understood (Dimitrov, 2010), particularly in turbulent environments that **require** disruptive strategies. Sometimes viewed as a static vision of CI, it can create paradoxes, such as the need to constantly adapt while maintaining consistent performance levels (Mignon, 2000).

There have been several studies that have identified the paradoxes of sustainability in companies (Mignon, 2000; Bloch and Nabat, 2009; Collins and Porras, 1994; Benghozi, 2009; Dumez, 2009; Mignon, 2009, Paipa et al., 2020). For Collins and Porras (2005), sustainability becomes a preservation instinct for companies, focusing on maintaining their "values" while being affected by constant fluctuations over structures, strategies and competitive dynamics. This particular "instinct" can be seen as a paradox (Dumez, 2009), a perpetual conflict of dealing with environmental constraints while simultaneously trying to transform them. There lies a paradox in contemporary companies where the recognition of the "non-eternal" existence of CI programs becomes extremely important (Dumez, 2009). Indeed, remaining the same is not realistic when dealing with different factors; a labor force, for example, can only enact change through innovation and evolution (Duffy, 2013). This discussion of stability and change is the "two sides of the same coin" (Perret and Josserand, 2003). For Pettersson (1990), the change aspect can be studied as an extension of the "*Darwinian*" theories extended to companies, where only the fit to compete in new circumstances can succeed, in which

maintaining the status quo is no longer an alternative. Therefore, sustainability can be studied as the result of constant efforts toward adaptation and progressive transformations through successive changes (Benghozi, 2009), and ensuring its success, it is important to find the right balance between change and continuity (Mignon, 2009). Paipa et al. (2020) highlight that consensus among researchers remains elusive regarding the conceptual success and failure factors influencing the sustainability of CI initiatives. This lack of alignment may result in issues such as inconsistent implementation practices, challenges in accurate progress measurement, and difficulties in establishing reliable benchmarks. According to Bateman and David (2002), the perception of achieving sustainability will only occur after all the possible influential elements have interacted together through continuous progress. This underlying reasoning suggests that sustainability is a "demanding definition" (Bateman and David, 2002), where a set of elements interact with each other to achieve a common goal (Podsakoff *et al.*, 2003). Consequently, this study is anchored in previous research about influential elements that help sustain CI programs (Bateman, 2005; Bateman and David, 2002; Cole, 2001; Jaca *et al.*, 2012; Coronado and Antony, 2002) and expand on Szwejcjewski et al's (2024) work including dynamic features of CI programs. Challenges such as inconsistent engagement, insufficient leadership support, and lack of structured evaluation methods contribute to a decline in CI program effectiveness. This study aims to confirm influential elements of CI initiatives that would help develop a maturity-benchmark model to guide organizations in maintaining long-term CI success.

The sustainability of CI initiatives remains an understudied topic. Moreover, there is a lack of research investigating the different viewpoints on the subject (Dimitrov, 2010). When approaching studies researching sustainability, there is an existing literature, albeit small, that addresses the issue of its definition over CI (Rich *et al.*, 2006; Bessant *et al.*, 1994; Bateman and David, 2002; Bloch and Nabat, 2009; Jaca *et al.*, 2012; Bortolotti *et al.* 2015). Despite the importance of sustainability growing in recognition, there is still no consensus on its definition that specifically focuses on the business context pointing directly to companies. Even though current research focuses on sustainability as a social goal to attain while preserving the planet and its resources (Hartini et al, 2020 ; Kaswan et al, 2024), this following research will focus on how to sustain CI programs. This could provide insights into the influential factors that support sustaining collective behaviors toward CI within an organization, serving as a foundational step toward achieving the social goal of sustainability. Accordingly, the first objective of this article is to contribute to the body of knowledge by promoting an understanding of the definition of sustainability regarding CI initiatives within a business set-up. The second objective is to identify the influential elements and the way these elements can have an effect on performance across a company. These influential elements will also be associated with the maturity stages of the company. Finally, the article will introduce a maturity-benchmark model capable of evaluating the degree of maturity of the most influential elements regarding CI programs.

The structure of this article is in accordance with the following: the next section serves as a literature review of CI initiatives, describing views of sustainability in an operational context and influential elements within a CI framework. The next section presents the methodology structured in three sub-sections: the research design, the self-assessment survey structuration and the maturity-benchmark model. A further section focuses on the results of the self-assessment survey while introducing an improved version of a maturity-benchmark model that supports the sustainability of CI initiatives in companies. Finally, the last section serves as a discussion and offers limitations of this work before presenting a conclusion of the article.

2. Literature review

2.1 Sustainability of CI initiatives

A methodological procedure was established to identify a consensual definition of sustainability, framed in a CI set-up. This proposition will allow practitioners to appraise existing literature (Soliman and Saurin, 2017; Akhigbe *et al.*, 2017). For this, the PRISMA protocol was used to conduct a

literature review (Moher *et al.*, 2010). The PRISMA protocol provides a set of steps to follow that guides the reviewer systematically through the selection process of included studies (Kiriakou *et al.*, 2013). Using PRISMA ensures the use of key methodological aspects (O’Leary *et al.*, 2015), and according to Moher *et al.* (2010) these types of protocols is necessary to reduce the likelihood of biased post hoc decisions in review methods. The protocol is composed of four main phases: Identification, Screening, Eligibility and Inclusion.

The strategy applied during the **Identification** phase included, among others, electronic databases and a set of keywords, which included *Sustain, Sustainability, Improvement, Performance and Long Term*. The results of the search are: **445 sources** from scientific databases (Science Direct, Emerald and Cairn), **52 sources** from grey literature (*e.g.*, books, theses, presentations and annual reports), where **30 sources** were duplicates (Figure 1).

During the following **Screening** phase, criteria were defined to exclude certain sources to filter out those not relevant to this inquiry. From this exercise, **398 sources** were excluded. The excluded sources and reasons for exclusion are:

- (i) Sources coming solely from case studies, without any interpretation approach regarding sustainability.
- (ii) Studies that approach organizational aspects related to sustainability, but only from a a directional management approach, without considering its impacts across lower levels of the company.
- (iii) Sources not correctly referenced with citations, since it is imperative to obtain a rich database supporting the objective from sources that have disclosed their references and thus verifiable.

In the next phase (**Eligibility**), 69 sources were analysed (abstracts, introduction, conclusion and further research) and 13 sources were excluded. This leaves 59 sources for the **Inclusion** phase to be deeply analysed.

Please insert figure 1 here

Figure 1. *PRISMA* flow diagram concerning interpretations of sustainability (Moher *et al.*, 2010).

In order to have a deeper understanding of the matter, the work completed by Dimitrov (2010) was used as an initial reference to contextualize the interpretation of sustainability across four dimensions (Table 1). A classification of the sources selected was carried out to analyse and compare the different interpretations of sustainability.

Please insert Table 1 here

Table 1. Dimensions of the definition of sustainability.

- The **Environmental/Societal** dimension is based upon aspects related to the planet’s wellbeing, long-term protection and interactions between population and their environment (Dimitrov, 2010).
- The **Political/Industrial** The concept of sustainability developed through political theories lies at the crossroads between strategy development, scientific knowledge, justice, and social equality (Cash *et al.*, 2003). The political aspect regarding production models over the long-term (Caccia, 2012) is also included. Therefore, this dimension focuses on decision-making and the ability of organizations to adapt to new working models and the incorporation of better practices.
- Along the **Economic** dimension, monetary prosperity and financial development are considered as factors of success (Higgins, 1977), aspects highly valued by current organizations.
- The last dimension considered is called **Semantics** as it is related directly to definitions from dictionaries, encyclopaedias or academia that have focused solely on the definition.

With this compendium of interpretations, divided into several dimensions, this research displays a sustainability definition fitting for a CI framework. Looking at previous works (Chirinos *et al.*, 2017a), and by analysing the results from our research, sustainability could be defined as:

"The capacity to maintain a high level of performance that is: achieved gradually over time, measurable, conducted according to well-defined processes, uses limited finite resources (financial, material, human, among others), and has the particularity of being able to adapt itself to contextual evolution".

This interpretation of sustainability, coupled with a CI framework, has constant adaptation at its core (Zairi, 2002) and addresses the studies focusing on the dilemma of sustainability (Mignon, 2000; Collins and Porras, 2005; Benghozi, 2009; Dumez, 2009; Mignon, 2009). As with any definition, some elements could contextualise it, and in the case of this article we try to identify these elements through exploratory research.

2.2 Influential elements characterizing the sustainability of continuous improvement programs

We aim to characterize influential elements that could help to sustain CI initiatives. Paipa et al (2020), states that certain elements can be considered as success factors (involvement, clear objectives, communication, commitment and support) and others as barriers (resistance to change, lack of motivation, difficulties on communication, etc.). Coronado and Antony (2002) declare that identifying such elements are critical to achieve the desired success. These influential elements could be considered as remarkable components that drive sustainability of CI programs, and their implementation could mark a positive difference or a complete waste of effort, time and economic resources.

A literature review was conducted in a previous research (Chirinos *et al.*, 2017), and, a group of bibliographical references (Duffy, 2013; Rich *et al.*, 2006; Jaca *et al.*, 2012; Coronado and Antony, 2002; Sánchez, 2012) were selected to identify a set of elements, and these were used as keywords and the basis for an exploratory research. This method is information seeking, designed to obtain it through a combination of questions and collection browsing (White and Roth, 2009). Additionally, a second search¹ was conducted to identify the literature reviews or quantitative models that will help us consolidate the influential elements regarding sustainability of CI programs. In this endeavour, it used results from previous articles (Table 2).

Please insert Table 2 here

Table 2. Referential sources regarding influential elements of CI programs.

As part of the methodology, the influential elements identified were used as keywords, along with: *continuous improvement, sustain, sustainability, long term* and *performance*. These were both used in French and English sources.

Additionally, to ensure relevance and rigor, articles were excluded based on the following criteria:

(i) The study did not address the relationship between specific elements (or an individual element) and Continuous Improvement (CI) initiatives, whether in terms of methodology, deployment, or general application.

(ii) The source lacked discussion on sustainability benchmarks or expectations regarding the long-term well-being of CI programs, as this aspect is critical to understanding the ongoing impact of these initiatives.

¹ TITLE ("lean" OR "continuous improvement" OR "learning organization" OR "organizational learning") AND ("sustainable" OR "sustainability" OR "sustain") AND ("literature" OR "quantitative" OR "survey" OR "review" OR "bibliometrics" OR "bibliometry" OR "biblio*" OR "education" OR "model" OR "framework")

(iii) The selected references did not present or report their results within the study, making it difficult to assess the impact or outcomes in relation to CI initiatives.

The above keywords were applied within four electronic databases (Science Direct, Emerald, Cairn, Theses) enabled the identification of **231 sources**. After applying the inclusion/exclusion criteria and eliminating duplicates, **101 referential sources** were omitted, leaving a final amount of **130 sources** to analyse. An additional search using Scopus helped us identified **190 additional sources**. After reviewing abstracts, **67 sources** were selected for analysis. At the end, **6 sources** were added.

From all these references, **16 elements** were identified as influential factors with the capacity to sustain CI programs, (the following list of elements, in the terms used in parentheses are synonyms used later for presentation purposes):

- Tools and methods for CI (*Tools.*)
- Change management (*Change.*)
- Leadership (*Leader.*)
- Organizational routines (*Routines.*)
- Performance of CI initiatives (*Perf.*)
- Employee engagement (*Engt.*)
- Risk management (*Risk.*)
- Knowledge management (*Know.*)
- Decision-making (*Decision.*)
- Training on methods and tools for CI (*Training.*)
- Organizational culture (*Culture.*)
- Communication management (*Comm.*)
- Time management (*Time.*)
- Resources (*Res.*)
- Diagnosis (*Diag.*)
- KPIs of performance results (*KPIs*)

Please insert Table 3 here

Table 3. Summary of identified influential elements.

After identifying the influential elements, the challenge now presents with measuring and analysing these elements within a business environment. A self-assessment survey was designed to investigate this.

3. Methodology

3.1 Research Method

Our study employs a self-assessment survey to gather crucial data needed to address our research question. Among the inquiries are general information from various companies, their perceptions of the impact of identified elements on sustainability, and the implementation of these elements within

the organizations. Our survey was structured on different sections, with predefined response types and assigned points to enable quantitative analysis. According to Kraut (1996), surveys designed to assess company concerns serve as an ideal method for evaluating trends and progress. The results obtained provide a quantifiable representation of the literature research already conducted, thereby facilitating the investigation of the established phenomena (Rindova and Kotha, 2001). To create the survey, Mont Blanc Industries' experts, a business cluster from the Haute-Savoie department in France, supported this research by funding it and by providing the database of the companies. Out of 300 targeted companies, 80 responded, representing those accessible and willing to participate. This approach facilitated the collection of valuable insights from a subset of the target population based on their availability and engagement ensuring a focused analysis of the business dynamics. This selection (1 person per company) of respondents was facilitated by the representatives of the business cluster, who identified suitable contacts from their database, relevant to the objective of the study.

By analyzing the influential elements previously identified, this research directly addresses the barriers outlined in the problem statement. The proposed maturity-benchmark model offers a structured framework for organizations to assess and refine their CI initiatives.

3.2 Self-assessment structuration and evaluation

The evaluation proposed for the self-assessment survey is based on three sections: the context, the perception of the impact of the influential elements, and the deployment within the companies.

The **first phase** focuses on gathering the following data:

- *Respondent's role.*
- *Business sector.*
- *Respondent's seniority.*
- *Size of the company.*
- *Respondent's level of knowledge regarding continuous improvement programs (Lean, Kaizen, WCM, etc.)*
- *Company's maturity regarding continuous improvement programs*

We would like to clarify how the maturity levels were collected. Respondents were asked to self-assess their company's maturity in CI efforts, selecting one of three levels: beginner, intermediate, or advanced. This was the primary criterion, further validated by the respondent's indication of how long the company has been engaged in CI practices (less than 3 years, 3 to 5 years, 5 to 10 years, or more than 10 years). In cases where these two criteria did not align, the researchers opted to assign the company a lower maturity level to ensure consistency.

The results and analysis of the specific stage of maturity are based solely on three key questions: the respondent's role within the company, their level of knowledge, and the company's maturity in continuous improvement programs. These selection criteria are strictly aligned with the article's focus on respondent perception.

The **second phase** addresses the perception of the impact of the influential elements. The following question was posed for each of the 16 influential elements considered in the study:

- *In your opinion, what is the impact of the element over the sustainability of continuous improvement programs?*

To measure the impact of the influential elements, the respondents choose one of the following four

answers: No impact, Low impact, Moderate impact, Significant impact.

To evaluate outcomes, measuring respondents' opinions is essential, and employing a dimensional scale is a common practice to achieve this goal (Bartikowski *et al.*, 2010). The approach utilized in this study was the Likert scale (Likert, 1932), primarily employed to assess abilities, attitudes, and opinions. In this case, it indicates the degree of agreement with positive or negative elements (see Table 4).

Please insert Table 4 here

Table 4. Impact rating scale.

The prioritization of categories based on their weightings may involve assuming risks where certain categories may not align with the perceptions of the respondents. Nevertheless, this risk has been acknowledged in the study by assigning greater weight to elements deemed to have a significant impact.

The **third phase** concerns the implementation of influential elements within the company. To gauge this perception, a PDCA (Plan, Do, Check, Act) approach was employed. Introduced by Edwards Deming in 1951 at the Japanese Union of Scientists and Engineers (JUSE), this method has since become foundational in continuous improvement initiatives. The use of the PDCA cycle serves to standardize improvements and encourages practitioners to view innovation and risk-taking as opportunities to better meet customer requirements (Lyu, 1996). With this methodology, the research situates each influential element within a problem-solving framework (Gorenflo and Moran, 2010; Backlund *et al.*, 2015), allowing respondents to choose from four different levels. For each of the 16 selected influential elements, four questions related to the PDCA cycle were presented:

- **Plan (P):** the question asked at this stage is focused on knowledge and the understanding level of the element in question (*e.g.*, *Knowledge of the leadership as a factor conducive to continuous improvement approaches*).
- **Do (D):** the question asked at this stage deals with the level of implementation of the element (*e.g.*, *The implementation of the leadership as a favourable factor for continuous improvement initiatives*).
- **Check (C):** in this case, the question concerns the evaluation of the element outcomes (*e.g.*, *Evaluation of the impact of leadership on continuous improvement initiatives*).
- **Act (A):** the question is inclined toward the recognition of possible improvements needed to correct or enhance the element inquired (*e.g.*, *Continuous improvement of leadership practices associated with improvement initiatives*).

For each step of the cycle, the respondents selected a deployment scale. The scale was: Inexistent, Existent, Methodical, Systematic, eXemplary (IEM SX) (Lyonnet, 2010). The IEM SX response levels are described in Table 5, and in this case, it is applied to the *Check* step of PDCA, as an example.

A quantitative rating scale was later assigned to obtain numerical data.

Please insert Table 5 here

Table 5. Deployment description and evaluation scale, applied to the Check step.

3.3 Maturity-benchmark model

After applying a numerical scale to represent the responses obtained from contacted companies more clearly and measurably, it becomes feasible to implement a maturity-benchmark model. This model

can compare companies against pre-established standards of excellence, identify trends, establish objectives, and study successful practices and strategies implemented by others.

The overall score for each element can be obtained as follows:

$$Me_i = \frac{\sum_{k=1}^K (V_{P_i} + V_{D_i} + V_{C_i} + V_{A_i})}{4 \times K} \quad (\text{Eq. 1})$$

Where:

- Me_i : is the arithmetic mean of the maturity of the element i (i from 1 to 16 elements)
- VP_j : is the value assigned by respondents to the Plan step for element i (0, 25, 50, 75, 100)
- VD_j : is the value assigned by respondents to the Do step for element i
- VC_j : is the value assigned by respondents to the Check step for element i
- VA_j : is the value assigned by respondents to the Act step for element i
- K : is the total number of companies considered by the survey (k from 1 to 80 companies)

The eventual score takes into account the level of deployment for each influential element based on a PDCA cycle (Figure 2), that eventually will affect the company score.

Please insert figure 2 here

Figure 2. Structure for the maturity evaluation of companies.

This information assists in situating any company within a new maturity-benchmark model. It is noteworthy that other works, such as the evolutionary model of continuous improvement behavior (Bessant et al., 2001) and the framework for conducting continuous improvement (Jørgensen et al., 2004), also exist. In both instances, these models delineate the capabilities necessary for companies to progress through each maturity phase. The proposed maturity-benchmark model complements the other models mentioned above.

4. Results and Analysis

The results were gathered over a three-month period from December 2016 to February 2017, obtaining 80 surveys from 80 different companies that had experience with CI programs. The assessment tool was electronic-based (companies were approached directly via e-mail) with the use of SPHINX2, an electronic tool for data gathering and analysis. The respondents were carefully selected through a targeted approach, facilitated by business cluster representatives, ensuring participants had relevant knowledge to improve the credibility of the responses. With 80 respondents representing the diversity of the 300 targeted companies, the findings can be considered generalizable, taking into account variability within the population (as shown in Figure 5). The 27% response rate aligns with typical business research surveys, where lower rates are common due to time constraints and organizational barriers (Mellahi & Harris, 2016). Although online surveys are essential for data collection, it's important to note that there were no pre-contacted participants or reminders sent out. The sufficiency of the sample is thus judged by its ability to answer the research questions.

The collected answers were assigned to quantitative scores, which were then integrated into a maturity-benchmark model based on the PDCA cycle. This model assesses the implementation stages of key CI elements, providing a comparative measure of CI maturity across companies. Additionally, responses were weighted and analyzed on a quantitative scale to capture an overall picture of CI practices and sustainability maturity within the sample. This maturity-benchmark model not only enables the measurement of CI implementation levels but also allows companies to gauge their performance

² <http://www.lesphinx-developpement.fr/>

against industry standards. In June 2024, to confirm the relevance of the information collected and to analyze the evolution of the companies' maturity over time, we resend the survey to the original respondents to assess any changes or developments since their initial responses. Using the database we maintained from the first exercise in 2017, we were able to contact these respondents directly. This approach provides valuable insights into how their maturity has evolved, giving us a more comprehensive understanding of the progress made. 45% of respondents said that the results were slightly similar or better, confirming the progress of their CI programs, but not significant enough to move them from one maturity level to another. This evolution can be explained by a turbulent period between 2020 and 2024 for companies. 25% of respondents reported a change of role in the company or a change of company, so they cannot properly assess the new maturity level. 30% of the respondents informed the researchers that the company has changed its strategic direction from CI to disruptive innovations such as Industry 4.0/5.0, slowly reducing its involvement in CI programs in order to devote more time to experimenting with I4.0 technologies (IA, AR/VR, IoT...).

4.1 General Context of the Company

Regarding the **role of respondents** in the company, 41% of the respondents worked as managers of CI programs, 17% had a director or manager role, 11% worked as production managers, 8% as process engineers, quality managers and external consultants, only 6% had a technician role and only 1% of the respondents worked as research engineers (Figure 3).

Please insert figure 3 here

Figure 3. The role of respondents in companies.

A notable feature of the results, almost half of the respondents have CI-related roles. This represents a positive aspect within the population studied, and the responses they can provide to the rest of the survey. From a general perspective, employees with a CI-related role may be considered more comfortable making better decisions (Mitchell, 2015), their determinations are based on a working knowledge of what is happening in the work floor.

While measuring the **level of the respondent's knowledge** on the topic of CI methods: 49% consider themselves to have *Confirmed knowledge* of CI, 46% *Intermediate* and only 5% of the cohort studied consider themselves as *Beginners* (Figure 4). This aspect is also aligned with the results from the respondents' role.

Please insert figure 4 here

Figure 4. Respondent's knowledge on CI methodologies.

For the **companies' maturity in terms of CI programs**, 46% of the group consider the company to have *Intermediate* knowledge, 34% as *Beginners* and 20% of respondents believe that their companies have *Confirmed* knowledge (Figure 5).

Please insert figure 5 here

Figure 5. Companies' maturity perception.

From the proposed self-assessment survey and concerning the last two results shown (Figure 4 and Figure 5): it is relevant to highlight that a basic level of knowledge is important when addressing the survey. In the self-assessment, it is exposed through a vocabulary related to improvement initiatives,

the introduction of concepts and elements (e.g., PDCA improvement cycle, organizational routines) as well as practical examples.

In the case of the respondent's knowledge, 95% of the population has a level of knowledge between *Confirmed* and *Intermediate*. Even though a comparison parameter has not been established, these results demonstrate a positive aspect for the potential understanding of the study objective.

In the case of the companies' maturity, 70% of them are between *Intermediate* and *Confirmed*, denoting a more balanced distribution; for each company's maturity, almost it is clear that the maturity of a company is not a reflection of the level of knowledge of the respondents.

4.2 Evaluation of the influential elements impact

The second part of the survey examines the **respondents' perception of the elements** previously identified and their impact over CI initiatives. In this case, the survey offers four possible response types: *No Impact*, *Low Impact*, *Moderate Impact* and *Significant Impact*. The first one concerns, the score that has been assigned to each of the answers allows each element to obtain an overall average mark (which is the result of all the answers collected from the eighty companies) (Figure 6). To obtain an overall score (Zhu and Kim, 2006), it has been used a procedure proposed in the work of Samson and Terziovski (1999), in which each response is collected so that the average of the individual elements can be estimated.

Please insert figure 6 here

Figure 6. Average score of the impact of the influential elements of CI initiatives.

In Figure 6, the elements have been arranged in ascending order of score to simplify the analysis. One can observe that the 2 elements *Methods and Tools* and *Risk Management* have the lowest score with 3.7 points (this score means that these two elements would have the least impact on CI initiatives) followed by *Time Management* and *Knowledge Management* with 3.8 and 3.9 points respectively. On the other hand, *Employee Engagement* has the highest score of 5.8 points (this score means that this element would have the most impact on CI initiatives), followed by *Corporate Culture and Leadership* at 5.3 points. It is also possible to evaluate the impact distribution of each element separately (Figure 7).

Please insert figure 7 here

Figure 7. Impact of the influential elements of CI initiatives.

On first sight, a large number represents the option *Significant Impact*, followed by *Moderate*, *Low* and *No Impact*. From these last two figures, it is easy to recognize that elements with a lower overall score are those with a higher number of responses distributed across the four options presented, conversely, those with higher overall scores are those with a higher number of *Significant impact* responses. In this article is also possible to ascertain that three highest elements (*Leadership*, *Corporate Culture* and *Employee Engagement*), are elements closely linked to two main aspects: the human factor and the management skills linked to the company strategy (Samson and Terziovski, 1999).

On the other hand, the last three elements with the lowest scores (*Methods and Tools*, *Risk Management*, *Time Management*) are those that, although they may also be related to corporate policies, are more inclined to an operational spectrum. About this duality (the nature of the elements), there are interesting readings based on the results obtained, specially from the research made by (Bortolotti *et al.*, 2015), in which they were able to distinguish two sets of practices: *Soft* and *Hard*.

Soft practices are related to relationships, interaction with people and people's behaviour; therefore, they are more difficult to control, measure and predict (Shah and Ward, 2007). Meanwhile, *Hard* practices are more technical and have a distinctive characteristic to be used as analytical tools (Bortolotti *et al.*, 2015).

Furthermore, it is possible to obtain a percentage of the distribution of impact scores (Figure 8).

Please insert figure 8 here

Figure 8. Distribution of responses regarding the impact.

Figure 8 shows that more than 60% of the responses consider a *Significant Impact* for all elements, 27% of the responses consider a *Moderate Impact*, 9.6% a *Low Impact* and finally, only 1.5% of the options selected are those concerning *No Impact*.

Nearly 90% of the responses are among the *Moderate* and *Significant* impacts, which shows the high relevance of the CI initiatives; this also shows the accuracy of the elements identified by the methodology developed, since less than 2% of the total amount of responses are selected at the *No impact* level.

4.3 Deployment of the influential elements within the company

The third part of the survey was designed to explore the influential elements in the context of a PDCA approach. Each step of this approach can be evaluated according to five different levels (Table 4) by averaging the scores with the mean (Glick and Fiske, 1996; Glick *et al.*, 2004) (Eq.1). The results were derived through four defined phases: the first focused on capturing the respondents' contextual perspectives, the second examined the impact and importance of the identified elements, the third analyzed how these influential elements are implemented within organizations, and the fourth developed a maturity-benchmark model that integrates both impact and implementation. As we focus on impact, we realize several facts: that more than half of the interviewed population has continuous improvement roles with which we can induce the degree of certainty in the answers given.

Figure 9, illustrates a histogram that represents the mean score of the PDCA by element across the 80 companies surveyed. Meanwhile, the four different curves represent each stage of the PDCA cycle separately. From the histogram, the influential element having the highest deployment rate is *Tools and Methods for Continuous Improvement*, with an overall score of 52.6, followed by *KPI of Performance Results* and *Organizational Routines* with 51 and 49.8 respectively. Meanwhile *Time Management* has the lowest overall score of 28.6, followed by *Risk Management and Change Management* with an overall score of 35.1.

The results show that in the majority of cases Plan has the highest score, followed by Do, Act and finally Check. It seems that the Check step is the least used. Usually, the Act step is expected to be the last one in the cycle, these results show two situations: (1) the theoretical PDCA cycle is not followed, (2) the Check step is perceived as the most difficult to implement. Check is the least developed stage, which is an interesting observation because it deals with self-awareness and changing course. This phase requires data analysis and assessment, but organizations may lack the proper data collection or tracking systems. Shah and Ward (2007) pointed out that when companies do not have robust systems in place to monitor progress, they tend to skip the evaluation of improvements. Moreover, Check and Act require reflection and adaptation, which can be harder to quantify or immediately implement. According to Hines *et al.* (2004), organizations often prioritize achieving visible results quickly, which leads to neglecting the necessary feedback and adjustments that occur in the later phases, additionally, the Act phase involves making changes based on the evaluation results, but organizations can be reluctant to modify or abandon implemented processes, especially if

initial results appear satisfactory. According to Mellahi and Harris (2016), businesses often fall into the trap of complacency, believing that the improvements are already sufficient and resisting further change.

Looking at the overall maturity of the elements, it is noticeable that the elements with a high degree of implementation are those that are easy to measure, such as: Tools and methods for CI, KPIs of performance results and Organizational routines, while soft elements such as: Change management, Risk management and Time management are less implemented.

Please insert figure 9 here

Figure 9. Deployment of the influential elements and their overall scores using a PDCA approach.

Focusing on the context, we noticed that over half of the interviewed participants have roles in continuous improvement, which helps enhance the certainty of their responses, moreover a high percentage of respondents are between confirmed and intermediate in terms of knowledge of continuous improvement processes. While analyzing the 16 influential elements impact, two impact groups are easily distinguished (with respect to the scores defined); those with the highest impact: Leadership, Corporate Culture and Employee Engagement and which are closely related to the personal interactions of individuals. And on the other hand, the elements with less impact: Methods and Tools, Risk Management, Time Management which are related to a more technical and operational aspect, this relationship can be easily compared with the soft and hard practices defined by Bortolotti et al. (2015).

The results highlight another notable issue: the misalignment between the perceived importance of specific elements (Figure 6) and their actual implementation within the PDCA framework (Figure 9). While elements such as Engagement (5.8), Culture (5.3), and Leadership (5.3) received the highest average scores, demonstrating that companies acknowledge their critical role in organizational maturity, their practical integration into PDCA practices remains limited. This gap is particularly striking for elements with high perceived value but insufficient operationalization. Several factors contribute to this gap. Companies may struggle to allocate resources or integrate these elements effectively into PDCA practices, even as they recognize their importance. Additionally, the lack of standardized practices, or frameworks to support implementation further delays their deployment. Addressing these barriers seems crucial for aligning perceptions with actionable strategies, ensuring these critical elements are embedded into operational processes.

The deployment analysis was conducted using the PDCA approach, leading to the clear identification of the most well-developed elements within the companies—Tools and Methods for Continuous Improvement, KPIs for Performance Results, and Organizational Routines. Additionally, the analysis revealed an intriguing shift in the distribution of stages, transitioning from a PDCA to a PDAC pattern, highlighting that the *Check* stage is the least developed among the four. This last situation invites us to reflect on why and how self-recognition and the identification of improvement actions are considered as an underdeveloped phase within the companies, opening a window for future studies.

4.4 Continuous improvement maturity-benchmark model proposal

The feedback gathered from the self-assessment survey opens up the possibility of introducing a complementary tool, represented by a maturity-benchmark model, for companies seeking to ensure the sustainability of their CI initiatives. The parameters used to assess this maturity are based on the work of Netland and Ferdows (2016) and their interpretation of maturity. Maturity is then defined as the combination of two parameters, **breadth** that represents how many entities within the company

(departments, teams, and operators) have started to implement improvement programs, and **depth** that reflects how such programs are being applied.

Any improvement initiative requires itself to be positioned with a benchmark (Becker, 2004). Companies recognize the importance of such reference models as business tools that forecast their behaviour in order to seek excellence (Van Looy *et al.*, 2011). Therefore, it is plausible to believe that models could be designed to embrace the behaviours of influential elements that had better describe the sustainability of CI initiatives.

Two main variables were considered in order to establish the desired maturity benchmark model. The overall *maturity* of the company formed by the *mean score of the 16 influential elements across the company*, which is based on their deployment (can be seen as **depth**) and the *standard deviation* among them, which translates the dispersion between the deployments of the elements) which can be seen as the **breadth**. Another feature that needs to be considered is the evaluation rating scale: to maintain consistency, the same scale used in section 4.1 (Table 5) (that utilises a five-level scale between 0 and 100), will also be used on this tool. To establish the boundary zones, it is necessary to: establish the upper limit of the maximum standard deviation, which defines the boundary of the definition zone. The organization's maturity limits boundary is calculated by using the average deployment of the 16 influential elements as follows:

$$M_{Avg} = \frac{[n \times SE_{Max} + (N-n) \times SE_{Min}]}{N} \quad (\text{Eq. 2})$$

Where:

M_{Avg} : is the average maturity of a company

SE_{Max} : is the maximum score that an element can obtain by a respondent (100)

SE_{Min} : is the minimum score that an element can have (0)

N : is the number of elements considered by the survey (16)

n : is the number of elements with a maximum score SE_{Max}

In Equation (4), $(N-n) \times SE_{Min}$ represents the calculation of elements that receive the minimum score, where N is the total number of elements, and n is the count of elements scoring at the maximum level (**SE_{Max}**). It is important to highlight that this approach doesn't imply that other elements are zero; instead, it assumes they are at the minimum threshold (**SE_{Min}**). The term $(N-n) \times SE_{Min}$ provides a way to capture the balance of scores, calculating a combined maturity score by weighting both maximum and minimum scores across the elements. This simplified binary view helps assess maturity by categorizing elements as either meeting or falling short of maximum standards, without including intermediate scores.

After simplification, the average maturity is such that:

$$M_{Avg} = \frac{100 \times n}{16} \quad (\text{Eq. 3})$$

The variance (M_{Var}) and standard deviation (M_{σ}) between the maturities of the different elements are calculated as follows:

$$M_{Var} = \frac{[n \times SE_{Max}^2 + (N-n) \times SE_{Min}^2]}{N} - M_{Avg}^2 \quad (\text{Eq. 4})$$

After simplification, the variance (M_{Var}) and standard deviation (M_{σ}) are such that:

$$M_{Var} = M_{\sigma}^2 = \frac{100^2}{16^2} n(16 - n) \quad (\text{Eq. 5})$$

$$M_{\sigma} = \frac{100}{16} \sqrt{n(16 - n)} \quad (\text{Eq. 6})$$

After some simple calculations, is noticeable that the equation of (M_{σ}) corresponds to a circle of centre $(50; 0)$ and radius 50 as follows:

$$(M_{Avg} - 50)^2 + (M_{\sigma} - 0)^2 = 50^2 \quad (\text{Eq. 7})$$

As a result, the maturity-benchmark domain of firms is limited by a semicircle as shown in Figure 10.

Please insert figure 10 here

Figure 10. Maturity definition zone.

When considering all the conditions and assumptions for evaluating a company's maturity specified earlier, it is important to note that a company's maturity rating is located within the semicircle described on the Figure 10, delimiting the boundary zones is necessary, therefore is important to be to establish maturity benchmarks.

A maturity-benchmark model that is both sufficiently clear and concise so that practitioners can position themselves within it and evaluate their continuous improvement projects appears to be warranted. Therefore, we propose a double five-level framework to fulfil this gap. The first five-level framework is obtained from the horizontal distribution of the average maturity into five equivalent phases and the second is obtained by the vertical distribution of the standard deviation into five such equal phases. This type of division has already been used in as the past, with examples such as the Quality Model for Organizational Processes (Crosby, 1979), the Capacity Maturity Model for Software (CMM) developed by Carnegie Mellon University (Paulk *et al.*, 1993), the Managing for Sustaining Success ISO 9004 model (Hoyle, 2009) and the Technology Readiness Calculator (Government Accountability Office, 2017). The names and value limits associated with the different phases of this maturity benchmark are proposed in Table 6 and graphically illustrated in Figure 11.

Please insert Table 6 here

Table 6. Maturity benchmark.

Please insert figure 11 here

Figure 11. Maturity benchmarks.

Although some companies have abandoned their CI initiatives or previous respondents have changed their position, we have decided to include all 80 companies previously interviewed in the following results. To place the maturity of the 80 companies, we propose to calculate for each company the average maturity and the standard deviation between the maturities of the elements of a company.

The company average maturity M_{ck} is thus calculated according to the following equation:

$$M_{Ck} = \frac{\sum_{i=1}^N M_{e_i}}{N} \quad (\text{Eq. 8})$$

The variance V_{Ck} and standard deviation σ_{Ck} are calculated as follows:

$$V_{Ck} = \frac{\sum_{i=1}^N (M_{e_i})^2}{N} - M_{Ck}^2 \quad (\text{Eq. 9})$$

$$\sigma_{Ck} = \sqrt{\frac{\sum_{i=1}^N (Me_i)^2}{N} - M_{Ck}^2} \quad (\text{Eq. 10})$$

Where:

M_{Ck} : is the arithmetic mean of the maturity of the company k Me_i : is the maturity of the element i (according to Eq. 1)

V_{Ck} : is the maturity variance of company k

σ_{Ck} : is the maturity standard deviation of company k

N : is the number of elements (i represents 1 to 16 elements)

This approach gives the overall maturity score of any company that completed the self-assessment survey, and this can then be positioned. The maturity-benchmark model used as its main input the 16 influential elements identified, taking into account, on the one hand, the overall maturity and, on the other hand, the degree of dispersion of each of them. These data helped us to create a notation rated between 0 and 100. Using minimum and maximum values, we defined 5 evaluation zones (*Disparate, Moderate, Heterogeneous, Homogeneous and Consistent*) or phases in which the organization is evaluated. The 80 companies that completed the self- assessment survey are positioned within the proposed maturity-benchmark model, in which the average of the influential element deployment is placed over the horizontal axis and the deviation among the deployment is along the vertical axis (Figure 12).

Please insert figure 12 here

Figure 12. Companies' deployment across the proposed maturity-benchmark model.

In Figure 12, it is evident that a high concentration of companies is at the early stages of the maturity evolution. We can also observe a low dispersion from the *Initiation* and *Structuring* stages. Meanwhile, in *Deployment*, the distance among the companies is more evident regarding the dispersion.

In the last maturity dispersion stages, the maturity-benchmark model demonstrates elevated dispersion levels, which suggests a broad diversity among the elements in terms of their deployment. However, Figure 12 shows that there are no companies located in the *Disparate* dispersion zone and very few companies are in the *Heterogeneous* zone. According to the proposed model and its zones, most companies deploy the elements in a *Moderate, Homogeneous* stage, while a few companies are placed alongside the *Consistent* dispersion stage. A comparative analysis of the different maturity zones reveals common traits shared by the studied companies presented (Table 7).

Please insert Table 7 here

Table 7. Comparative analysis of organization among maturity zones.

These results, although conclusive, only represent a specific moment and it is essential to carry out

second and third samples to be able to evaluate the evolution of the companies in a much more accurate way.

5. Discussion and limitations

Sustaining continuous improvement programs conveys a paradox in its understanding, which has been argued already by some authors (Mignon, 2000; Collins and Porras, 2005; Benghozi, 2009; Dumez, 2009; Mignon, 2009). This research addressed this paradox by defining sustainability within a CI framework and identifying 16 influential elements that affect the sustainability of CI programs. The findings highlight a significant gap in understanding how CI programs are maintained within companies, often overlooked by trends in technological and organizational innovation (Hines et al., 2023) and influenced by external economic contexts such as COVID-19 (Kaswan et al, 2024). However, CI initiatives remain a competitive advantage that some companies continue to nurture. The methodology used in this article involved collecting, studying, and classifying all available interpretations of sustainability into four dimensions, thus creating a complete characterization of sustainability within CI programs. A self-assessment survey was developed in order to gather data from companies including: the general context of the company, the impact perception of the elements and the deployment of the identified elements. The results offers also an identification of 16 influential elements that can help practitioners better understand their environments and predict risks affecting performance of CI initiatives (Keating et al., 1999). This led to the development of a maturity-benchmark model, enabling companies to evaluate their deployment of these influential elements and position themselves accordingly.

This article succeeds in adding a new approach based on the use of an improvement framework in the form of a PDCA cycle and serves as a synthesis of the influential elements, linking them to the maturity level of the company. A remarkable diversity was found among the influential elements, from measurability to their human or technical inclination (Bortolotti *et al.*, 2015). This study extends previous theories by integrating sustainability into the dynamic progression of CI programs. By emphasizing that sustainability is in flux and cannot sustain a static definition, the research aligns with CI methodologies such as PDCA, Kaizen, and Improvement Kata. This perspective challenges traditional static views and highlights the need for continuous reassessment and adaptation, contributing to a deeper theoretical understanding of sustainability in CI programs.

From the influential elements' deployment, two major results can be extracted. The first corresponds with perception. Perception plays a huge role on the results obtained, as a way that the brain provides us to make sense of the information received (Bokeno, 2011). The respondents' perception shows that the influential elements with the greatest impact are those linked with human interaction, which is arguably more difficult to measure (Bortolotti *et al.*, 2015). That interaction provides flexibility to handle circumstances (Wang *et al.*, 2018). Meanwhile, the least impactful elements are linked with an operational point of view. These results suggest the strong relevance of human interaction with CI. It is coherent with recent findings (Costa et al, 2019). A self-assessment survey is a way to show evidence of a specific criterion (Pitt, 1999), where other influences would not affect individuals. In the case of this article, the classification of the influential elements regarding impact can differ from the one related to their deployment. The second outcome relates to PDCA and the details of each cycle step. The stage PLAN is the highest regarding deployment, followed by DO, ACT and CHECK (Figure 7). This leads us to understand that the proposed framework is useful to analyse the way the company embraces CI. The steps PLAN-DO are the easiest steps to achieve and put into practice. These stages are linked with strategies and are more tangible to measure (Gorenflo and Moran, 2010). The steps CHECK-ACT are linked with improvement, feedback and adaptability to change, and they are the less developed across the companies. These results invite us to go further and explore the causes of such outcomes. This is the reason why a maturity-benchmark model was developed. By evaluating the dynamic behaviour of the influential elements, it helps companies to position themselves. In this case, two proposals are presented, the first regards the constraints *used* to evaluate maturity. This kind of

evaluation uses as a reference the definition of maturity based on breadth and depth concepts (Netland and Ferdows, 2016). The second proposal deals with the nomenclature utilised to distinguish the different levels. Such terminology was created to close the gap between research terms and an industrial setup.

The analysis also reveals a critical gap between the perceived importance of maturity elements and their integration within the PDCA framework. Companies highly value elements like Engagement (5.8), Culture (5.3), and Leadership (5.3), yet their operationalization remains limited, potentially due to resource constraints, insufficient tools, or a lack of standardized practices. Cognitive biases may also play a role, with companies overestimating the impact of these elements without embedding them effectively into actionable frameworks. Furthermore, deficits in skills and training, particularly in decision-making and PDCA-specific practices, delay the deployment of these influential elements. Bridging this gap requires aligning perceptions with concrete actions by investing in tools, comprehensive training programs, and decision-making frameworks to fully integrate these high-priority elements into operational processes, ensuring sustained organizational maturity.

No study is without its limitations, and this is no exception. Firstly, despite best efforts, there always exists the potential of the approach for managing sustainability not being adequately robust, which could have affected the total number of references, and the existence of other possible dimensions to categorize sustainability. More dimensions could add richness and inclusivity to the definition. Regarding the influential elements, a possible limitation concerns the chosen methodology; specifically, the use of exploratory research does not intend to propose a final and definitive solution regarding the research problem (Dudovskiy, 2016). Nevertheless, it will help to shed some light on a problem that has to be studied: the identification of elements that characterize the sustainability of CI. Conducting generalization of the results will help examine the status of an organization and help develop new strategies and practices to pursue sustainability (Hines *et al.*, 2023 ; Kombowski *et al.*, 2023). Considering the self-assessment survey, only one person from each company many was approached to complete the survey, which can create some misconceptions or misinterpretations regarding certain elements and expose the results to a single response bias. In addition, respondents were almost entirely formed by people working in high-rank positions, which can generate a skewed view of the company regarding the improvements. Therefore, it would be interesting to include other job profiles to add different points of view on the matter. Another possible limitation is based on the nature of our methodology regarding the self-assessment survey, which was not repeated to evaluate possible changes in the company that could eventually affect the influential elements' evolution, therefore, no discussion has been introduced about the possible capacities and behaviours linked with such evolution. Also is very important to stress that the answers also come from the same respondents. Therefore, it is imperative to bear in mind that the responses pertain to a single person's perception of their current situation. Additionally, regarding the maturity of the company, such a definition was not explained, which could create confusion regarding the different options presented. From a statistical point of view, the maturity-benchmark model has not been evaluated to measure the degree of repeatability and reliability to serve as a basis for other studies. This limitation has been measured and accepted, with the desire that the maturity-benchmark model will be evaluated on a second and third iteration in future research.

6. Conclusion and avenues for research

The primary objectives of this article are to define sustainability within the context of CI programs and to consolidate the 16 influential elements that affect the sustainability of these programs. Another objective is to acknowledge the richness and depth of sustainability by highlighting its different interpretations, thereby facilitating improvements through clearer communication of company objectives. The study successfully identifies and consolidates 16 influential elements that impact the sustainability of CI programs. By evaluating these elements, the research develops a maturity-benchmark model that enables companies to position themselves and assess their performance. This

model serves as a practical tool for practitioners to gauge their progress and identify areas for improvement. The findings underscore the dynamic nature of sustainability, emphasizing that it cannot be captured by a static definition and must be integrated into CI frameworks, especially in the context of Industry 4.0 (Alsadi *et al.*, 2023 ; Hines *et al.*, 2023).

Theoretically, this study contributes to the understanding of the influential elements that help sustain CI programs by offering a nuanced interpretation that takes into account their dynamic and evolving nature. The research highlights the importance of a flexible and adaptive approach to the sustainability of CI initiatives, challenging static definitions and encouraging continuous reassessment and adaptation. This perspective aligns with the principles of CI methodologies such as PDCA, Kaizen, and Improvement Kata, reinforcing the concept of sustainability as an ongoing, iterative process. For practitioners, the maturity-benchmark model provides a valuable tool for assessing and enhancing the sustainability of CI initiatives. By identifying and understanding the 16 influential elements, companies can better navigate the complexities of implementing CI programs and ensure long-term success. The model aids in setting targeted objectives and focusing efforts on specific elements that drive sustainability, thereby improving overall performance and competitiveness. Practitioners can use the PDCA approach to evaluate and refine their CI strategies continuously.

Limitations of the study are explained with a focus on the potential variability in the interpretation and implementation of the 16 influential elements across different companies and industries. The study's findings are based on a specific sample, which may not fully capture the diversity of CI practices globally. Additionally, the model's reliance on self-reported data may introduce bias, affecting the accuracy of the results. Future research should aim to include a larger and more diverse sample to validate the model and explore variations in CI practices.

Future research should explore the impact of the 16 influential elements by examining the knowledge levels of respondents and comparing their behaviors. This could involve detailed case studies of individual companies to identify commonalities and differences in CI practices. Additionally, researchers should consider integrating new trends such as sustainability/environmental concerns and Industry 4.0/5.0 into the model to enhance its relevance. Moreover, lingering questions arise as new trends are adopted by organizations, such as the integration of digital technologies and lean methodologies. This integration is increasingly recognized as essential in today's business environment. Rather than viewing it as an abandonment of continuous improvement (CI), it should be considered as a way to enhance and evolve CI practices. Lean principles focus on eliminating waste and improving efficiency, while digital technologies provide powerful tools for data analysis, process automation, real-time feedback, and decision-making. Analyzing this integration—especially from the disruptive perspective of digital trends like Industry 4.0 and 5.0—alongside the incremental enhancement of CI methodologies, could lead to a more comprehensive improvement strategy. Digital would foster innovation and enable CI efforts to thrive in a rapidly changing landscape while CI principles can serve as a prerequisite for a successful digital transformation (Hines *et al.*, 2023). The integration of Lean principles and digital technologies creates a foundation for continuous innovation (CI), enabling efficiency and adaptability while requiring cultural shifts to embed CI into organizational strategies effectively. Savolainen (1999) emphasizes that continuous innovation (CI) is essential for organizations to remain competitive in the face of disruption. By integrating CI with emerging technologies, companies can ensure their improvements are both adaptable and sustainable. Rather than abandoning CI for technological innovation, organizations are revisiting CI after experimenting with disruptive technologies. Achieving this, however, requires a significant cultural and managerial transformation. Companies must adopt customer-centric strategies, redefine managerial roles to act as enablers rather than controllers, and foster transparent, dynamic communication. These shifts are crucial for embedding CI into organizational practices, ensuring its compatibility with technological advancements and long-term resilience. Christiansen and Varnes (2015) explore the interplay between stability and flexibility in organizational rules, emphasizing how rules are adapted or replaced to respond to change. This adaptability is essential for competitiveness

but poses challenges for management, as it demands balancing operational efficiency with fostering innovation. To navigate this, managers must adopt a proactive approach, recognizing the cyclical nature of rule changes and understanding the factors driving these shifts, including their generational evolution.

Further studies could also investigate the macro and sub-level perspectives of the model, including the PDCA improvement cycle and the IEMXS scale, to provide a more comprehensive understanding of CI sustainability. By expanding the study population and incorporating these additional factors, future research can establish more robust benchmarks and offer deeper insights into the conditions necessary for sustaining CI initiatives. This will help companies not only assess their maturity levels but also develop capacities associated with the influential elements, ultimately contributing to the advancement of CI practices.

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References

- Akhigbe, T., Zolnourian, A. and Bulters, D. (2017), "Compliance of systematic reviews articles in brain arteriovenous malformation with PRISMA statement guidelines: Review of literature", *Journal of Clinical Neuroscience*, Vol. 39, pp. 45-48.
- Alsadi, J., Antony, J., Mezher, T., Jayaraman, R., and Maalouf, M. (2023) "Lean and Industry 4.0: A bibliometric analysis, opportunities for future research directions", *Quality Management Journal*, Vol. 30 No. 1, pp. 41-63.
- Backlund, F., Chronéer, D. and Sundqvist, E. (2015), "Maturity assessment: towards continuous improvements for project-based organisations?", *International Journal of Managing Projects in Business*, Vol. 8 No. 2, pp. 256-278.
- Bagherian, A., Gershon, M. and Kumar, S. (2023), "Paving the way to successful six sigma implementation: investigating critical success factors as precursors: an empirical study", *The TQM Journal*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/TQM-05-2023-0157>
- Bartikowski, B., Kamei, K. and Chandon, J. (2010), "A verbal rating scale to measure Japanese consumers' perceptions of product quality", *Asia Pacific Journal of Marketing and Logistics*, Vol. 22 No. 2, pp. 179-195.
- Bateman, N. (2005), "Sustainability: the elusive element of process improvement", *International Journal of Operations & Production Management*, Vol. 25 No. 3, pp. 261-276.
- Bateman, N. and David, A. (2002), "Process improvement programs: a model for assessing sustainability", *International Journal of Operations & Production Management*, Vol. 22 No. 5, pp. 515-526.
- Becker, M. (2004), "Organizational routines: a review of the literature", *Industrial Corporate Change*, Vol. 13 No. 4, pp. 643- 678.
- Benghozi, P. (2009), "La pérennité : un lest ou un gyroscope pour l'entreprises ?", *Revue Française de Gestion*, Vol. 192 No. 2, pp. 177-181.
- Bessant, J., Caffyn, S. and Gallagher, M. (2001), "An evolutionary model of continuous improvement behaviour", *Technovation*, Vol. 21 No. 2, pp. 67-77.
- Bessant, J., Caffyn, S., Gilbert, J., Harding, R. and Webb, S. (1994), "Rediscovering continuous improvement", *Technovation* Vol. 14 No. 1, pp. 17-29.
- Bhasin, S. (2012), "Performance of Lean in large organisations", *Journal of Manufacturing Systems*, Vol. 31, pp. 349-357.
- Bhuiyan, N. and Baghel, A. (2005), "An overview of continuous improvement: from the past to the present," *Management Decision*, Vol. 43 No. 5, pp. 761-771.
- Bloch, A. and Nabat, E. (2009), "Pérennité organisationnelle et transformation. Concilier l'inconciliable ?" *Revue Française de Gestion*, Vol. 2 No. 192, pp. 113-126.
- Bokeno, R. (2011), "Learning in conflict: revisiting the role of perception", *Development and Learning in Organizations: An International Journal*, Vol. 25 No. 2, pp. 15-17.
- Bortolotti, T., Boscari, S., Danese, P., (2015). Successful lean implementation: Organizational culture and soft lean practices. *International Journal of Production Economics*, Vol. 160, pp. 182-201.

- Caccia, C. (2012), "The politics of sustainable development", *International Advances in Engineering and Technology*, Vol. 11, pp. 830-843.
- Cash, D., Clark, W., Alcock, F., Dickson, N., Eckley, N. and Guston, D. (2003), "Knowledge systems for sustainable development", *Proceedings of the National Academy of Sciences*, Vol. 100 No. 14, pp. 8086-8091.
- Chirinos, O., Pralus, M., Habchi, G. and Messaoudène, Z. (2017a), "Company sustainability, an overview of the existing literature: in search of a common definition and its influence over continuous improvement endeavours", article presented at The 20th World Congress of the International Federation of Automatic Control (IFAC2017), 9-14 July, Toulouse, France.
- Chirinos, O., Pralus, M., Habchi, G. and Messaoudène, Z. (2017b), "Coping with New Business Challenges: Analysis of the Elements that Affect the Sustainability of Continuous Improvement Program", in *Bousonville T., Melo T., Rezg N., Vernadat F. (Ed.), Proceedings of the 2017 International Conference on Industrial Engineering and Systems Management (IESM) in Saarbrücken, Germany, 2017*, pp.493-498.
- Christiansen, J.K. and Varnes, C.J. (2015), "Drivers of changes in product development rules: How generations of rules change back and forth", *European Journal of Innovation Management*, Vol. 18 No. 2, pp. 218-237.
- Cole, R.E. (2001) "From Continuous Improvement to Continuous Innovation", *Quality Management Journal*, Vol.8, No. 4, pp. 7-21.
- Collins, J.C. and Porras, J.I. (2005), *Built to Last: Successful Habits of Visionary Companies*, Random House. New York.
- Coronado, R.B. and Antony, J. (2002), "Critical success factors for the successful implementation of six sigma projects in organisations", *The TQM Magazine*, Vol. 14 No. 2, pp. 92-99.
- Costa, F., Lispi, L., Staudacher, A. P., Rossini, M., Kundu, K. and Cifone, F. D. (2019) "How to foster Sustainable Continuous Improvement: A cause-effect relations map of Lean soft practices," *Operations Research Perspectives*, Elsevier, vol. 6
- Crosby, P. (1979), *Quality is Free: The Art of Making Quality Certain*, Penguin, New York.
- Dakov, I. and Novkov, S. (2007), "Assessment of the lean production effect on the sustainable industrial enterprise development," *Business: Theory and Practice*, Vol. 8, p. 183.
- Delbridge, R. and Barton, H. (2002), "Organizing for continuous improvement: structures and roles in automotive components plants," *International Journal of Operations & Production Management*, Vol. 22 No. 6, pp. 680-692.
- Dimitrov, D.K. (2010), "The paradox of sustainability definitions", article presented at the 6th Asia Pacific Interdisciplinary Research in Accounting Conference, July 12-13, Sidney, Australia, available at: http://apira2010.econ.usyd.edu.au/conference_proceedings/APIRA-2010-073-Dimitrov-The-paradox-of-sustainability-definitions.pdf (accessed 1st October 2019).
- Dudovskiy, J. (2016), *The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance*, Research Methodology, Pittsburgh.
- Duffy, G.L. (2013), *Modular kaizen: continuous and breakthrough improvement*, ASQ Quality Press, Milwaukee.
- Dumez, H. (2009), "Identité, performance et pérennité organisationnelle", *Revue Française de Gestion*, Vol. 192 No. 2, pp. 91-94.
- Esmacilian, B., Behdad, S. and Wang, B. (2016), "The evolution and future of manufacturing: A review", *Journal of Manufacturing Systems*, Vol. 39, pp. 79-100.
- Flores, M.M. and Vanoni, G., (2016), "Competencias directivas requeridas por los CEO ante la complejidad de las organizaciones del siglo xxi", *Suma de Negocios*, Vol. 7 No. 16, pp. 113-124.
- Glick, P. and Fiske, S. (1996), "The Ambivalent Sexism Inventory: Differentiating hostile and benevolent sexism", *Journal of Personality and Social Psychology*, Vol. 70 No. 3, pp. 491-512.
- Glick, P., Lameiras, M., Fiske, S., Eckes, T., Masser, B. and Volpato, C. (2004), "Bad but Bold: Ambivalent Attitudes toward Men Predict Gender Inequality in 16 Nations", *Journal of Personality and Social Psychology*, Vol. 86 No. 5, pp. 713-728.
- Gorenflo, C.W. and Moran, J. (2010), "The ABCs of PDCA", available at: http://www.phf.org/resourcestools/Documents/ABCs_of_PDCA.pdf (accessed 15 October 2019).
- Government Accountability Office (GAO) (2017), "Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects—Exposure", available at: <https://www.gao.gov/products/GAO-16-410G> (accessed 1st October 2019).
- Hartini, S., Ciptomulyono, U., Anityasari, M. and Sriyanto (2020), "Manufacturing sustainability assessment using a lean manufacturing tool: A case study in the Indonesian wooden furniture industry", *International Journal of Lean Six Sigma*, Vol. 11 No. 5, pp. 943-971. <https://doi.org/10.1108/IJLSS-12-2017-0150>
- Higgins, R.C. (1977), "How much growth can a firm afford?", *Financial Management*, pp. 7-16.
- Hines, P., Holweg, M. and Rich, N. (2004), "Learning to evolve: a review of contemporary lean thinking", *International Journal of Operations & Production Management*, Vol. 24 No. 10, pp. 994-1011.
- Hines, P., Tortorella, G.L., Antony, J. and Romero, D. (2023) "Lean Industry 4.0: Past, present, and future", *Quality*

- Management Journal*, Vol. 30 No. 1, pp. 64-88.
- Hoyle, D. (2009), *ISO 9000 quality systems handbook using the standards as a framework for business improvement*, Routledge, Abingdon, England.
- Imai, M. (1986), *Kaizen* (Vol. 201), New York: Random House Business Division.
- Jaca, C., Viles, E., Mateo, R. and Santos, J. (2012), "Components of sustainable improvement systems: theory and practice", *The TQM Journal*, Vol. 24 No. 2, pp. 142-154.
- Jørgensen, F., Boer, H. and Gertsen, F. (2004), "Development of a team-based framework for conducting self-assessment of continuous improvement", *Journal of Engineering and Technology Management*, Vol. 15 No. 4, pp. 343-349.
- Kaswan, M.S., Rathi, R., Antony, J., Cross, J., Garza-Reyes, J.A., Singh, M., Preet Singh, I. and Sony, M. (2024), "Integrated Green Lean Six Sigma-Industry 4.0 approach to combat COVID-19: from literature review to framework development", *International Journal of Lean Six Sigma*, Vol. 15 No. 1, pp. 50-79. <https://doi.org/10.1108/IJLSS-11-2022-0227>.
- Keating, E., Oliva, R., Repenning, N., Rockart, S. and Serman, J. (1999), "Overcoming the improvement paradox", *European Management Journal*, Vol. 17 No. 2, pp. 120-134.
- Kiriakou, J., Pandis, N., Fleming, P., Madianos, P. and Polychronopoulou, A. (2013), « Reporting quality of systematic review abstracts in leading oral implantology journals », *Journal of Dentistry*, Vol. 41 No. 12, pp. 1181-1187.
- Komkowski, T., Antony, J., Garza-Reyes, J.A., Tortorella, G.L. and Pongboonchai-Empl, T. (2023) "A systematic review of the integration of Industry 4.0 with quality-related operational excellence methodologies", *Quality Management Journal*, Vol. 30 No. 1, pp. 3-15.
- Kraut, A.I. (1996), *Organizational surveys: tools for assessment and change*, Jossey-Bass Publishers, San Francisco.
- Likert, R. (1932), "A technique for the measurement of attitudes", *Archives of Psychology*, Vol. 140, pp. 5- 53.
- Lopes, N. R., Filho, M. G., Ganga, G. M. D., Tortorella, G. L., Callefi, M. H. B. M. and Tamara de Lima, B. (2023) "Critical factors for sustaining lean manufacturing in the long-term: a multi-method study", *European Journal of Industrial Engineering* Vol. 17, N°1, pp. 60-89.
- Lucey, J., Bateman, N. and Hines, P. (2005), "Why major lean transitions have not been sustained," *Management Services*, Vol. 49 No. 2, pp. 9-13.
- Lyonnet, B. (2010), "Amélioration de la performance industrielle: vers un système de production Lean adapté aux entreprises du pôle de compétitivité Arve Industries Haute-Savoie Mont-Blanc" [dissertation], Université de Savoie, Annecy.
- Lyu, J. (1996), "Applying Kaizen and automation to process reengineering", *Journal of Manufacturing Systems*, Vol. 15 No. 2, pp. 125- 132.
- Mellahi, K. and Harris, L.C. (2016), "Response rates in business and management research: An overview of current practice and suggestions for future direction", *British Journal of Management*, Vol. 27 No. 2, pp. 426-437.
- Mignon, S. (2009), "La pérennité organisationnelle : un cadre d'analyse", *Revue Française de Gestion*, Vol. 35 No. 192, pp. 75-89.
- Mignon, S. (2000), "La pérennité des entreprises familiales: un modèle alternatif à la création de valeur pour l'actionnaire". *Finance Contrôle Stratégie*, Vol. 3 No. 1, pp. 169-196.
- Mitchell, J.S. (2015), "Operational excellence: journey to creating sustainable value", John Wiley & Sons, New Jersey.
- Moher, D., Liberati, A., Tetzlaff, J. and Altman, D. (2010), "Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement", *International Journal of Surgery*, Vol. 8 No. 5, pp. 336-341.
- Netland, T. and Ferdows, K. (2016), "The S-Curve Effect of Lean Implementation", *Production and Operations Management*, Vol. 25 No. 6, pp. 1106-1120.
- O'Leary, B., Bayliss, H. and Haddaway, N. (2015), "Beyond PRISMA: Systematic reviews to inform marine science and policy", *Marine Policy*, Vol. 62, pp. 261-263.
- Oliva, F.L. (2016), "A maturity model for enterprise risk management," *International Journal of Production Economics*, Vol. 173, pp. 66-79.
- Paipa-Galeano, L., Bernal-Torres, C. A., Otálora, L. M. A., Nezhad, Y. J., & González-Blanco, H. A. (2020), "Key lessons to maintain continuous improvement: A case study of four companies", *Journal of Industrial Engineering and Management*, Vol. 13 No.1, pp. 195-211.
- Paulk, M., Curtis, B., Chrissis, M. and Weber, C. (1993), "Capability maturity model, version 1.1", *IEEE Software*, Vol. 10, No. 4, pp. 18-27.
- Perret, V., Josserand, E., (2003), *Le paradoxe : Penser et gérer autrement les organisations*, Ellipses Marketing, Paris.
- Pettersson, M. (1990), "Continual Improvement for Competitive Advantage", *Industrial Management & Data Systems*, Vol. 90 No. 1, pp. 4-10.
- Pitt, D.J. (1999), "Improving performance through self-assessment", *International Journal of Health Care Quality Assurance*, Vol. 12 No. 2, pp. 45-54.
- Podsakoff, P.M., Mackenzie, S.B., Lee J-Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Social Psychology*, Vol. 88 No. 5,

pp. 879–903.

- Rich, N., Bateman, N., Esain, A., Massey, L. and Samuel, D. (2006), *Lean evolution: lessons from the workplace*, Cambridge University Press, UK.
- Rindova, V.P. and Kotha, S. (2001), “Continuous “morphing”: Competing through dynamic capabilities, form, and function”, *Academy of Management Journal*, Vol. 44 No. 6, pp. 1263-1280.
- Rosca, D., Greenspan, S., Febowitz, M., and Wild, C. (1997), “A decision-making methodology in support of the business rules lifecycle,” *Proceedings of the Third IEEE International Symposium on Requirements Engineering*, IEEE, pp. 236-246.
- Samson, D. and Terziovski, M. (1999), “The relationship between total quality management practices and operational performance”, *Journal of Operations Management*, Vol. 17 No. 4, pp. 393-409.
- Sánchez, J.M. (2012), “Assessing Sustainability of the Continuous Improvement through the Identification of Enabling and Inhibiting Factors”, [dissertation], Virginia Polytechnic Institute and State University, Virginia, USA.
- Savolainen, T.I. (1999), “Cycles of continuous improvement: realizing competitive advantages through quality,” *International Journal of Operations & Production Management*, Vol. 19 No. 11, pp. 1203-1222.
- Schreyögg, G. and Kliesch-Eberl, M. (2007), “How dynamic can organizational capabilities be? Towards a dual-process model of capability dynamization,” *Strategic Management Journal*, Vol. 28 No. 9, pp. 913-933.
- Shah, R. and Ward, P.T. (2007), “Defining and developing measures of lean production”, *Journal of Operations Management*, Vol. 25 No. 4, pp. 785-805.
- Soliman, M. and Saurin, T. (2017), “Lean production in complex socio-technical systems: A systematic literature review”, *Journal of Manufacturing Systems*, Vol. 45, pp. 135-148.
- Sony, M., Antony, J. and Naik, S. (2020), "How do organizations implement an effective LSS initiative? A qualitative study", *Benchmarking: An International Journal*, Vol. 27 No. 5, pp. 1657-1681. <https://doi.org/10.1108/BIJ-10-2019-0451>
- Srinivas, P., Gedam, V.V., Narkhede, B. E., Narwane, V. S. and Gotmare; A. (2022) “Sustainable implementation drivers and barriers of lean-agile manufacturing in original equipment manufacturers: a literature review study”, *International Journal of Business Excellence*, Vol. 26 N°1, pp. 61-94
- Swarnakar, V., Tiwari, A.K. and Singh, A.R. (2020), "Evaluating critical failure factors for implementing sustainable lean six sigma framework in manufacturing organization: A case experience", *International Journal of Lean Six Sigma*, Vol. 11 No. 6, pp. 1069-1104. <https://doi.org/10.1108/IJLSS-05-2019-0050>
- Szwejczewski, M., Lillis, B., Belvedere, V. and Grando, A. (2024), "Sustaining lean changes: the influence and significance of different change sustainability factors in maturing lean change programmes", *Journal of Manufacturing Technology Management*, Vol. 35 No. 1, pp. 54-73. <https://doi.org/10.1108/JMTM-05-2023-0182>
- Van Looy, A., De Backer, M. and Poels, G. (2011), “Defining business process maturity. A journey towards excellence”, *Total Quality Management and Business Excellence*, Vol. 22 No. 11, pp. 1119-1137.
- Villarreal, B., Garza-Reyes, J. and Kumar, V. (2016), “A lean thinking and simulation-based approach for the improvement of routing operations”, *Industrial Management & Data Systems*, Vol. 116 No. 5, pp. 903-925.
- Wang, B., Kang, Y., Childerhouse, P. and Huo, B. (2018), “Service supply chain integration: the role of interpersonal relationships”, *Industrial Management & Data Systems*, Vol. 118 No. 4, pp. 828-849.
- White, R. and Roth, R. (2009), “Exploratory Search: Beyond the Query-Response Paradigm”, *Synthesis Lectures on Information Concepts, Retrieval, And Services*, Vol. 1 No. 1, pp. 1-98.
- Zairi, M. (2002), “Total quality management sustainability: what it means and how to make it viable”, *International Journal of Quality & Reliability Management*, Vol. 19 No. 5, pp. 502.
- Zhu, W. and Kim, M. (2006), “Analyzing Likert-Scale Data Using Item Response Theory Unfolding Model”, in *Preliminary Program for 2006 AAHPERD National Convention and Exposition in Salt Lake City, USA, 2006*.
- Zollo, M. and Winter, S.G. (2002), “Deliberate learning and the evolution of dynamic capabilities,” *Organization Science*, Vol. 13 No. 3, pp. 339-351.

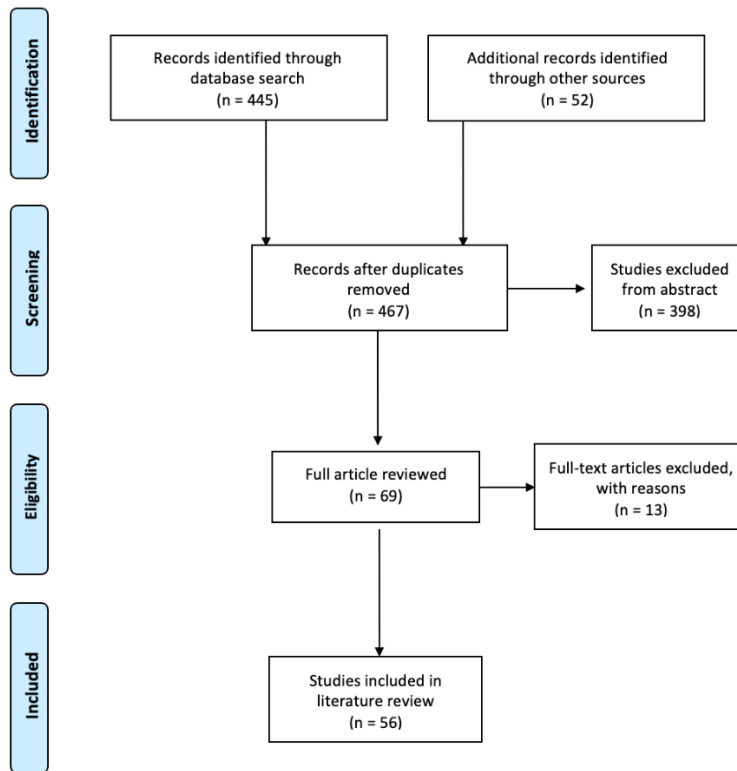


Figure 1. PRISMA flow diagram concerning interpretations of sustainability (adapted from Moher *et al.*, 2010).

Dimension	Definition
<i>Environmental/Societal</i>	Interactions between people and their environment
<i>Political/Industrial</i>	Ability of organizations to adapt to new work patterns to seek the longevity of their processes
<i>Economic</i>	Good resource management to meet ongoing consumption and, ultimately, meeting needs
<i>Semantics</i>	Definitions from dictionaries and encyclopaedias; general definition studies

Table 1. Dimensions of the definition of sustainability (Source: Authors own work)

Reference	Influential elements
Coronado and Antony (2002)	Involvement and commitment of the management, Cultural change, Communication, Organizational infrastructure, Training
Rich <i>et al.</i> (2006)	Resource management, Leadership style, Methods and tools, Business culture, KPI of continuous improvement initiatives, Encouragement of teamwork, Selection of services to improve, Training, Communication management
Jaca <i>et al.</i> (2012)	Strategic management, performance, Change management, Knowledge management, CI
Sánchez (2012)	The commitment of management and its involvement, KPI of the performance, Programs linked to strategic objectives, Routines and problem solving, Selection of methods, Resource management, Employee participation, Change management, Recognition of participants, Training, Communication management, Staff commitment,

	Encouragement of teamwork, Provide facilitators, Selection of services to improve
Duffy (2013)	Realistic awareness and understanding of the upcoming challenges, Solid methods, Training, Resource management
Srinivas et al (2022)	Management, employee, Technology, Organization, Infrastructure, Finance, Government support and policies, Stakeholders, Behavioral, Sustainability, Strategy, Standard/systems
Sony et al (2020)	Financial performance, Organization-wide LSS culture, Organization-wide innovation culture, Continuous training and retraining of employees on LSS, Continuous top management support, Linking LSS to business strategy, Linking LSS to the customer, Project selection strategy, Communication, Recognition and compensation systems, Social benefits and green benefits
Swarnakar et al (2020)	A total of 26 Critical Failure Factors (CFF) were identified and organized within the following categories: Driving CFF, Linkage CFF, Autonomous CFF, Dependent CFF
Bagherian et al (2023)	Competence of belt System employees, Project management skills, Organizational economic capability, Leadership commitment and engagement.
Lopes et al (2023)	Communication, Continuous improvement-oriented culture, Cross-functional teams, Employee engagement, Improvement program objectives linked to strategic goals, Knowledge sharing, Leadership, Experienced people drive lean initiatives, Learning, Planning lean program activities, Project selection, Project team selection, Provision of a facilitator to support the program, Team understanding of improvement goals, Teamwork, Top management support, Training, Use of indicators to verify the maintenance of improvements made, Use of the appropriate methodology
Szwejczejewski et al (2024)	Leadership factors, Political factors, Employee's individual factors, Managerial factor

Table 2. Referential sources regarding influential elements of sustainability improvement programs (Source: Authors own work)

Element	Interpretation	References
Tools and methods for CI	Structured approaches and practical instruments that provide overall guidelines facilitating the achievement of the desired outcomes. They serve as guidelines to keep the improvement initiative on the right “track.” enabling focus and management of processes.	Jaca et al., 2012
Change management	In the context of CI, change management involves an organization's adaptive capacity to both gradual and radical changes, often challenged by employee resistance, which requires managers to actively shift mindsets to sustain performance.	Lucey et al., 2005
Leadership	Seen as the capability to feel responsible for guiding a work team on applying CI tools, animate activities, training engagement and training improvement.	Paipa et al., (2020)

Organizational routines	<p>In a CI context, organizational routines help identify root causes of issues, reduce uncertainty, and serve as dynamic tools for knowledge transfer and skill development across the company.</p> <p>Organizational routines are stable behaviors within a company that represent responses to internal or external environmental factors, often appearing as recognizable, repetitive patterns involving multiple actors.</p>	Zollo, M. and Winter, S.G. (2002)
Performance of CI initiatives	<p>To sustain CI, it's essential to evaluate the performance of the chosen approach and align it with strategic objectives.</p> <p>Using clear indicators for monitoring and control allows for measuring the long-term viability of CI, providing insight into areas such as resource management effectiveness.</p>	Dakov, I. and Novkov, S. (2007)
Employee Engagement	<p>Employee engagement, though variably defined, generally reflects a positive attitude towards the company and is linked to job satisfaction and behavior, impacting performance indicators such as retention, productivity, and safety.</p> <p>Since CI is closely tied to change, employee openness to change is essential; disengaged employees can lead to issues like increased absenteeism, safety risks, higher production costs, and lower productivity.</p>	Lucey et al., (2005)
Risk management	<p>Regarding CI, risk represents the likelihood of events impacting a company's objectives, and risk management is essential for controlling these cumulative effects, including internal and external factors such as competition, innovation demands, and regulatory changes.</p> <p>Effective risk management involves analyzing, assessing, and monitoring risks within company processes, which are critical for navigating an increasingly complex organizational environment.</p>	Oliva, F.L. (2016)
Knowledge management	<p>Knowledge sharing by operational employees fosters a self-renewing process, where inputs and outputs constantly interact to enhance processes and drive continuous progress. Knowledge management involves the methods and techniques a company uses to share knowledge, serving as a potential source of innovation and organizational capability.</p>	Delbridge, R. and Barton, H. (2002)

Decision-making	Decision-making involves identifying solutions to problems and opportunities while aligning with strategic models and the company's external environment, it also helps companies manage uncertainty by avoiding biases like old habits, oversimplified mental models, or rigid procedures.	Rosca, D., Greenspan, S., Febowitz, M. and Wild, C. (1997)
Training on methods and tools for CI	Training equips employees with skills and knowledge, not only in technical areas but also in how they think and act, fostering effective problem-solving, well-trained employees are more adaptable to change, as training encourages involvement in company policies and shares lessons learned to reduce future risks of failure.	Jaca et al., (2012)
Organizational culture	Corporate culture, a shared set of values, beliefs, and assumptions, influences the practices and effectiveness of CI, shaped by company experience and management systems, key cultural facilitators for successful CI include valuing incremental innovation, recognizing everyone's creative potential, and maintaining a positive attitude toward mistakes, fostering a long-term approach beyond simple cost reduction.	Bessant, J., Caffyn, S. and Gallagher, M. (2001)
Communication management	Communication management is both a process and an activity, involving the exchange of information through shared symbols and defining communication needs, with key processes being coordination, intervention, and feedback an effective communication, supported by an open-door policy and reliable channels, fosters CI initiatives and helps companies meet competitive challenges by creating an environment where employees can fulfill expectations.	Sánchez, J.M. (2012)
Time management	Time management serves as an efficiency indicator, helping companies prioritize tasks, adapt to changes, and allocate resources effectively to meet program objectives. It is closely linked to decision-making, as it determines how resources are allocated to improve selected processes within a specific timeframe.	Jaca et al., (2012)
Resources	While many companies focus on financial and time resources, effective CI also depends on human resources, a crucial factor often overlooked in implementation success. Resources are essential for driving successful CI strategies, especially in the early stages of implementation, where proper allocation is critical to avoid failure.	Jaca et al., (2012)

Diagnosis	Diagnostics should consider the dynamics of various interacting factors within the company, as these factors evolve over time, as a potential risk an incorrect diagnostic in CI can result from relying on data that doesn't account for the company's ongoing changes during improvement initiatives.	Schreyögg, G. and Kliesch-Eberl, M. (2007)
KPIs of performance results	Ensuring the sustainability CI requires evaluating the performance of the chosen approach, aligning it with strategic objectives, Using clear indicators for monitoring and control allows companies to measure the potential for long-term CI success.	Bessant, J., Caffyn, S. and Gallagher, M. (2001)

Table 3. Summary of identified influential elements (Source: Authors own work)

Impact of elements	Rating Scale
No impact	0
Low impact	1
Moderate impact	3
Significant impact	6

Table 4. Impact rating scale (Source: Authors own work)

Degree of deployment	Description	Rating scale
(I) Inexistent	There is no evaluation of any kind with respect to the selected element	0
(E) Existent	The evaluation of the selected element is carried out but the results are not used	25
(M) Methodical	The evaluation of the selected element is carried out, results are used but not shared at all levels of the company	50
(S) Systematic	The evaluation of the selected element is carried out, the results are used and shared at all levels of the company	75
(X) eXemplary	The evaluation of the selected element is carried out, the results are used, shared at all levels of the company and used as good practices outside the company.	100

Table 5. Deployment description and evaluation scale, applied to the Check step (Source: Authors own work)

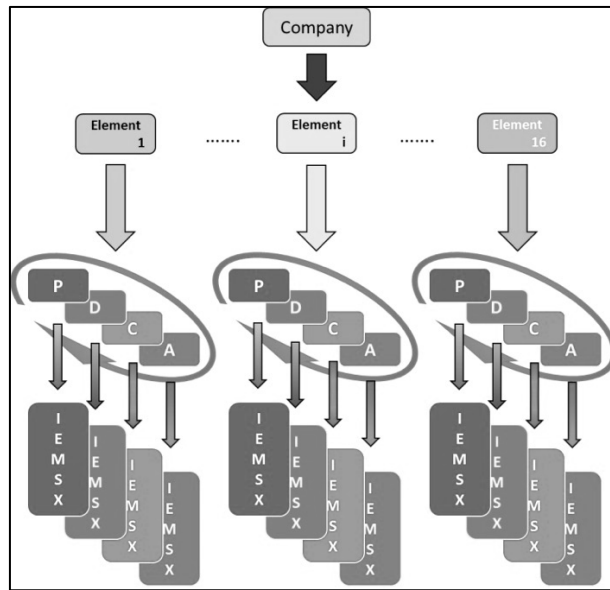


Figure 2. Structure for the maturity evaluation of companies (Source: Authors own work)

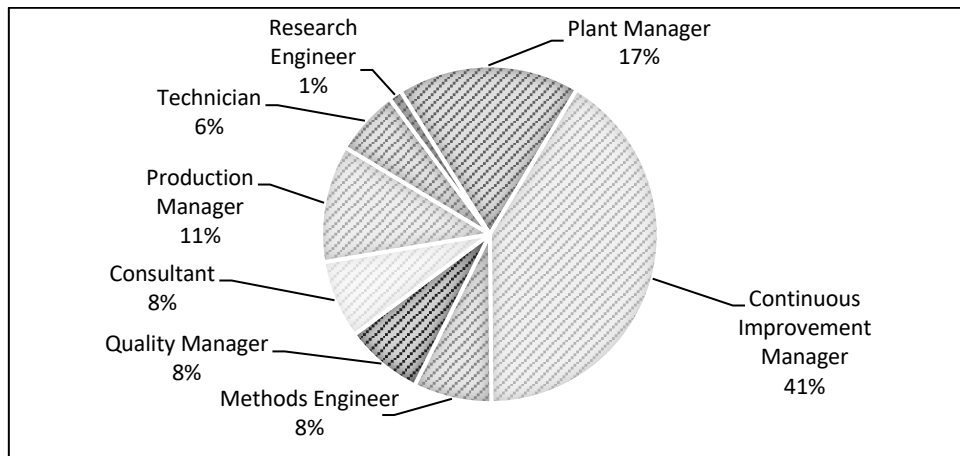


Figure 3. The role of respondent in companies (Source: Authors own work)

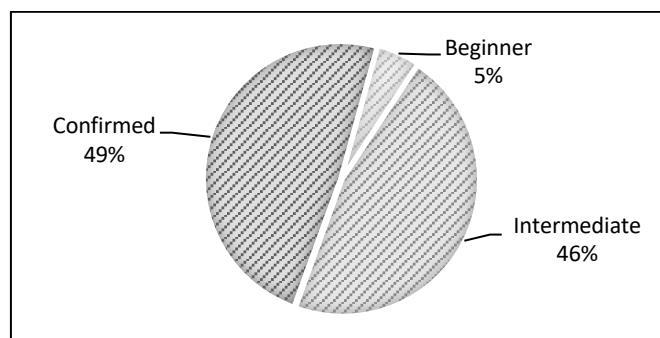


Figure 4. Respondent's knowledge on CI methodologies (Source: Authors own work)

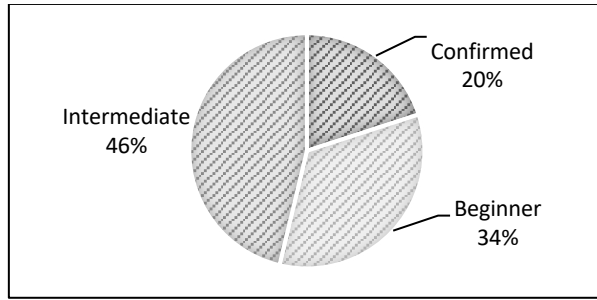


Figure 5. Companies' maturity perception (Source: Authors own work)

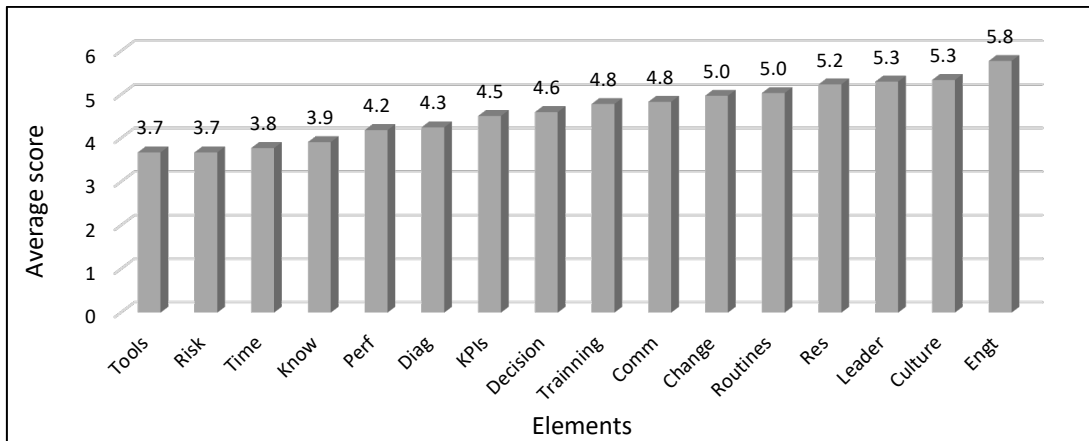


Figure 6. Average score of the impact of the influential elements of CI initiatives (Source: Authors own work)

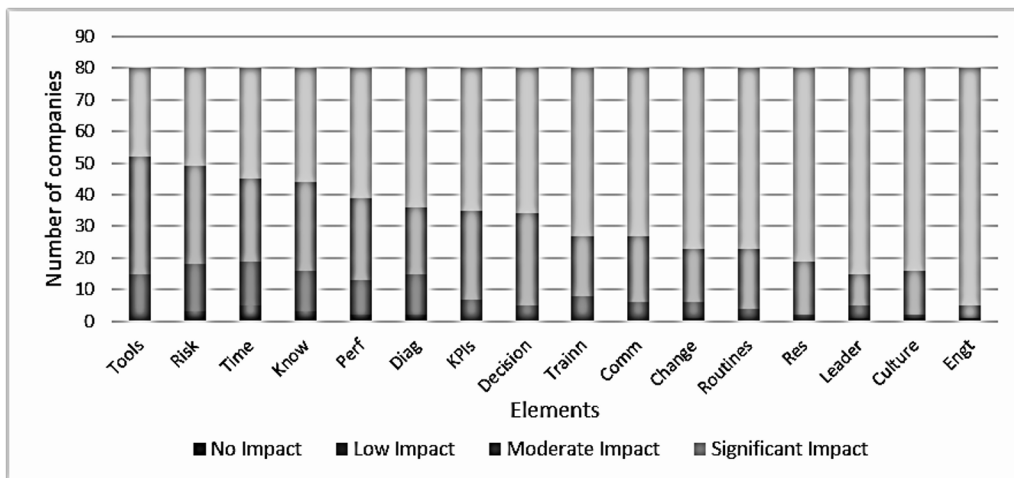


Figure 7. Impact of the influential elements of CI initiatives (Source: Authors own work)

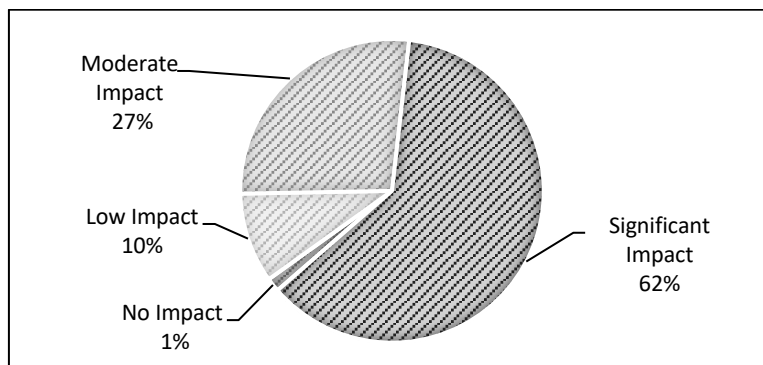


Figure 8. Distribution of responses regarding the impact (Source: Authors own work)

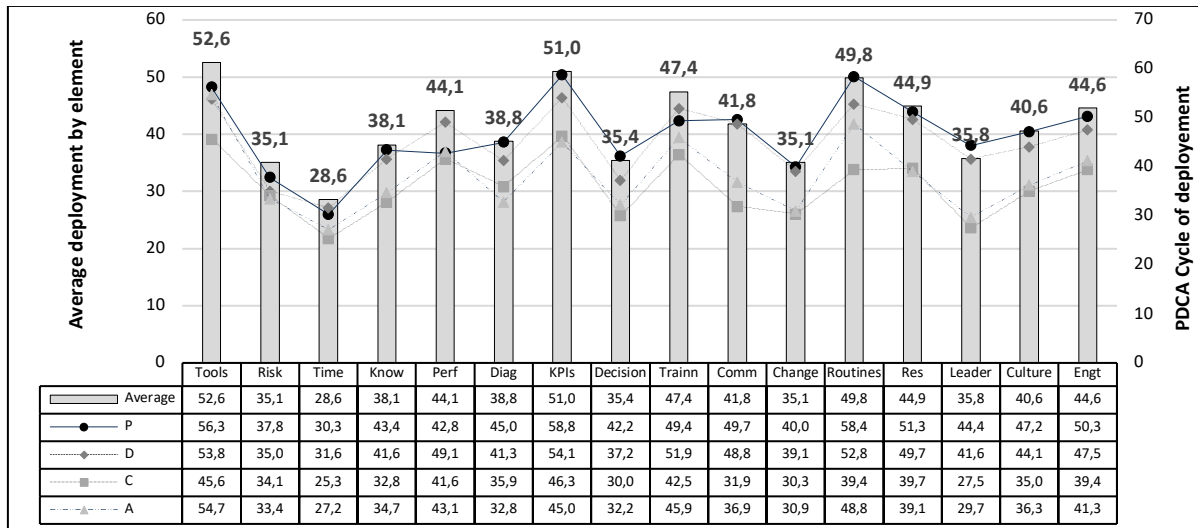


Figure 9. Deployment of the influential elements and their overall scores using a PDCA approach (Source: Authors own work)

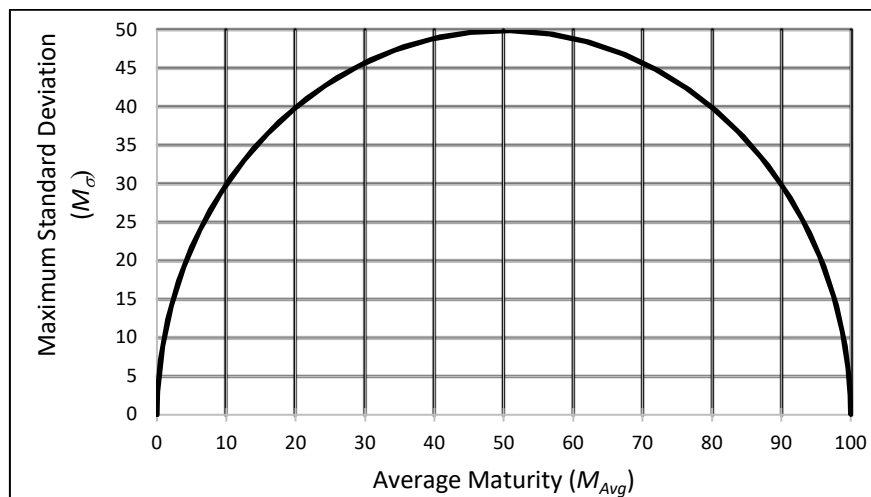


Figure 10. Maturity definition zone (Source: Authors own work)

Average Maturity		Standard Deviation (σ)	
Designation of Sustainability phases	Limit Scores	Designation of Dispersion phases	Maximum Limit Scores
Initiation	[0-20]	Consistent	[0-10]
Structuring	[20-40]	Homogeneous	[10-20]
Deployment	[40-60]	Moderate	[20-30]
Maturation	[60-80]	Heterogeneous	[30-40]
Perpetuation	[80-100]	Disparate	[40-50]

Table 6. Maturity benchmark (Source: Authors own work)

Zone	Common Traits	Areas of attention
Perpetuation	Highest deployment scores across almost all elements strongest performance in leadership, corporate culture, engagement and performance indicators, which denotes	Low areas of concern; continued focus on sustaining high performance is essential and protection of the current system

	a balanced deployment across strategic and operational elements, showing high maturity in CI practices. While, leadership and strategic alignment ensure a strong culture of improvement, high scores in tools and methods demonstrate effective use of ci methodologies.	from perturbation coming from strategic changes.
Maturation	Strongest in organizational routines, methods and tools and leadership. Effective routines and use of tools for CI implementation are robust and combined with leadership can be transformed into defying strategic vision.	Slightly weaker in risk management and change management which translate into challenges in adapting to change or managing risks at the operational level.
Deployment	Deployment scores generally in the 40–60% range, reflecting moderate CI maturity. Stronger in leadership and employee engagement, indicating a focus on human-centric practices while on the other hand varied performance in operational elements like communication and risk management. In general, there is a good balance between strategic and operational elements in some areas.	Lower consistency in operational practices like time management and diagnostics. Reflective phases of the PDCA cycle (Check and Act) need greater focus.
Structuring	Uneven or limited CI maturity, some elements like routines and engagement are reasonably well-deployed.	Limited focus on strategic alignment and leadership, a low deployment of performance indicators and change management that could hamper adaptability.
Initiation	Weak performance across both strategic and operational elements, particularly in leadership, change management, and performance indicators. Some isolated improvements in methods and tools in select cases.	Lacks leadership focus, engagement, and strategic alignment, struggles with implementing even foundational CI practices. Requiring foundational changes in leadership, culture, and resource allocation.

Table 7. Comparative analysis of organization among maturity zones (Source: Authors own work)

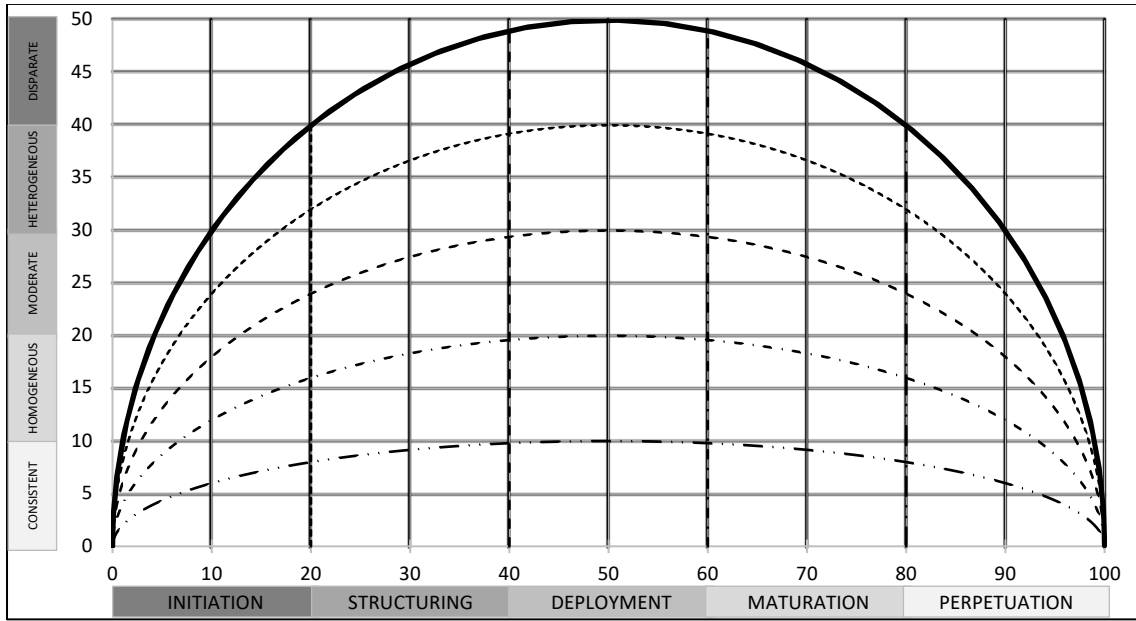


Figure 11. Maturity benchmarks (Source: Authors own work)

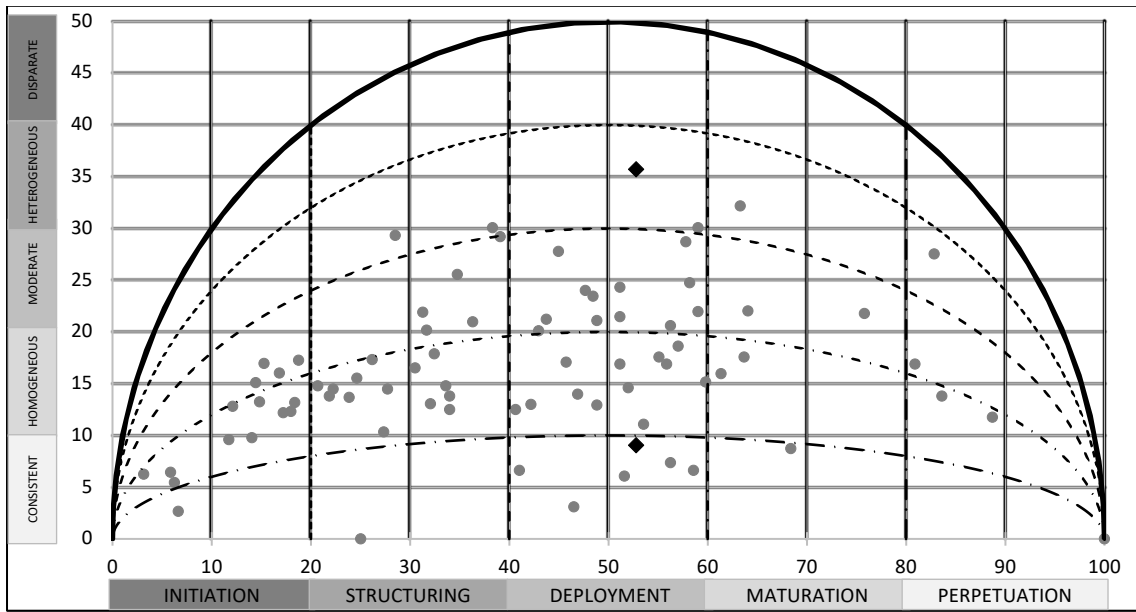


Figure 12. Companies' deployment across the proposed maturity-benchmark model (Source: Authors own work)