International Journal for Quality Research 20(1) 165–178
ISSN 1800-6450

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**Article info:**
Received 03.12.2024.
Accepted 07.06.2025.

DOI – 10.24874/IJQR20.01-10

# MAPIC - A NEW COMPREHENSIVE METHODOLOGY FOR PROCESS IMPROVEMENT

***Abstract:*** *The use of process improvement methodologies to assist and support the improvement of processes has proven to be an important mechanism for effectively implementing these improvements. However, there is difficulty in choosing the best methodology and to ensure that it will lead to the best improvement results. In this sense, the research questions of this work can be formulated as the following: H1 - There are differences between the major process improvement methodologies and gaps not covered by them; H2 - A new process improving methodology may mitigate the gaps identified in the existing process improvement methodologies.*

*Comparing the main process improvement methodologies available in the literature, namely, PDCA, Six Sigma, DMAIC, QC Story, 8D, TOC and Lean, it was proven the research question H1. To validate the research question H2 a new process improvement methodology, the MAPIC, was then proposed and compared with the other methodologies. From a theoretical view point, the research question H2 was validated, because the MAPIC covers the existed gaps from the others methodologies, namely, that there is no phase to promote proactive continuous improvement, nor to validate the proposed improvement before its implementation. As for its practical validation, the MAPIC is being applied in a case study and the results will be presented in further work.*

***Keywords:*** *Process improvement methodologies, Continuous improvement, MAPIC methodology, Comparison study.*

## 1. Introduction

The battle for market share has led organizations to seek ways to adapt more rapidly to abrupt changes between supply and demand, technological advancements, and economic and regulatory pressures to avoid losing the race for their survival. The consistency of these changes has forced companies to embrace projects to improve their processes, in some cases more reactively, and in others, preferably, more proactively. Process improvement (PI) is a widely practiced strategy in manufacturing and service companies around the world to improve products or services quality, reduce lead times, optimize costs, and improve delivery reliability, in order to achieve performance excellence and customer satisfaction (Aichouni et al., 2021).

Therefore, there is a growing need to investigate and understand the critical success factors of existing PI methodologies and to

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identify effective strategies to overcome these challenges, lest resources be wasted on non-integrated and ineffective solutions for organizational needs. According to Paipa-Galeano et al. (2020), one of the factors influencing the success of continuous improvement is the appropriate choice of PI methodology. Additionally, it is known that even applying a PI methodology to support a process improvement, sometimes, the expected results are not completely achieved in the companies. In this sense, this work aims to compare the most important PI methodologies, such as PDCA, Six Sigma, DMAIC, QC Story, 8D, TOC, and Lean and propose a new methodology with a broader spectrum of application and addressing some gaps found in other methodologies. Based on the above discussion, the research questions of this work can be formulated as the following two hypotheses:

H1: There are differences between the major PI methodologies and gaps not covered by them;

H2: A new PI methodology may mitigate the gaps identified in the existing PI methodologies.

By answering these two research questions, the potential contribution of this work will be to make available on the market a new methodology that can mitigate the gaps found, thus opening the possibility for improvement processes to be more effective and efficient. In order to answer the previous hypotheses, the rest of this paper is organized as follows. Section 2 identifies and describes the main process improvement methodologies and section 3 compares them and identify the gaps that are not covered by all of them, opening the door for the necessity of a new methodology. Section 4 presents a new PI methodology, the MAPIC, and compares with the methodologies revised in section 2. To finalize, some conclusions and future works are made in Section 5.

## 2. Literature Review

### 2.1. Approach to the Different Interpretations of Process Improvement

According to Sousa et al. (2020) there are two types of PI: (i) systematic problem solving and (ii) improvement projects. The difference between these two types occurs from the identification of the need for improvement. Improvement projects are linked to the strategic objectives of the company (clients, competitors, etc.) and systematic problem solving refers to a set of activities that will be executed in a reactive or preventive way to a problem. However, the authors of this work prefer to consider that PI is only associated with the first one (systematic problem solving). This position is justified because, improvement projects not only are more related to strategic decisions, but also, because originate disruptive improvements, requiring the use of project investment analysis techniques and project management tools to manage the bigger dimension of these projects and the quantity of resources consumed over large periods of time.

Continuous improvement is an increasingly relevant topic in organizations in recent decades, presupposing the necessary improvement of organizational processes. The study of Zighan & Ruel (2023) finds that continuous improvement enhances SMEs' resilience in the short term and long term. It can translate the concept of resilience into tangible working constructs for SMEs in visualizing and making decisions about their risks, adapting, absorbing changes and prevailing over time. In many organizations, there is a concern about putting the philosophy of continuous improvement into practice, for which purpose teams/sections/departments dedicated to the identification, development, and implementation of process improvement projects are even created. Despite that, many organizations continue to face challenges in the effective implementation of continuous improvement. Firstly, the variety of methodologies and their tools available in the literature, which promise operational excellence and customer satisfaction, can lead companies to become overwhelmed by the complexity of their application and maintenance over time, as well as the cost of their implementation. Additionally, issues such as resistance to change, lack of leadership, and inadequate organizational culture also contribute to hindering the correct adoption and sustainability of these practices (Maurer, 2012). Therefore, many organizations seek consulting services and support from academia to assist their improvement processes, particularly when complexity and/or cost and/or uncertainty are higher.

The designation of PI methodologies, or problem solve, or also referred to as work improvement, has evolved into the designation of continuous improvement methodologies. However, the latter designation presupposes that there is a culture of continuous improvement within the organization, possibly supported by organizational management practices and models that encourage employees to regularly identify and formulate improvement proposals. Despite the difference between the two designations, in both cases, when it is decided to improve something related to the production process, there is a need for process improvement, so the methodology to be applied from that point onwards may be the same.

In light of the above, this work focuses on process improvement in a broad sense and its methodologies, regardless of the existence of continuous improvement practices or models. In summary, the practice of continuous improvement entails the application of process improvement methodologies, and therefore, both designations - process improvement and continuous improvement - can be accepted.

Independently of the Interpretations of PI meaning, there is a widespread consensus that the application of PI methodologies can bring internal and external benefits for the organizations. At the internal level, the application of process improvement methodologies promotes the definition of a work structure, with clear stages and guidance in the form of objectives, with tasks to lead improvement efforts most efficiently. Choosing and following an improvement methodology allows for an objective assessment of the success of implemented changes and provides valuable information for future improvement initiatives (Tempelman & Schildmeijer, 2022). At the external level, process improvement methodologies are widely recognized in the market, attributing credibility to companies that adopt them correctly (Hoang, 2014). Many methodologies have associated certifications, such as the inclusion of the PDCA cycle in the ISO 9001:2015 Quality standard, or are widely adopted in specific sectors, such as the 8D methodology in the automotive industry (Zarghami & Benbow, 2017). Consequently, demonstrating that an organization follows an established methodology generates business and facilitates partnerships because it allows entities to speak the same organizational language. Additionally, according to Putnik & Ávila (2016), resource scarcity in companies requires optimization of their utilization. The authors suggest that teams take decision-support measures in resource management, following an PI methodology, identifying critical resources to create a priority list that can meet production needs and customer requirements.

### 2.2. Revision of Process Improvement Methodologies

As previously mentioned, the designation of process improvement methodologies may also appear with other designations in the literature, such as problem-solving methodologies, or with the designation of work improvement methodologies. The meaning intended in this work is the same, but it is more focused on the production process, hence the designation adopted in this work is PI methodology.

The most common and referenced methodologies in the literature for process improvement include the folowing: the PDCA cycle -

Plan-do-check-act, whose authorship is attributed to Shewhart and later developed by Deming (Shewhart, 1939; Deming, 2000); the Six Sigma DMAIC - Define, Measure, Analyze, Improve, and Control, associated with Smith at Motorola (Smith, 1993), in short Six Sigma; only DMAIC; the QC Story - Quality Control Story, attributed to Ishikawa (Ishikawa, 1985); the 8D - Eight Disciplines, attributed to Ford Motor Company (Ford Motor Company, 2002); the TOC - Theory of Constraints, authored by Goldratt (Goldratt, 1994); and the Lean Thinking methodology, credited to Womack and Jones (Womack and Jones, 1996), in short Lean. Some of the mentioned methodologies are more focused on a specific objective than others, as it will be seen further, however, they are equally valid as process improvement methodologies.

The PDCA cycle is the most widely used methodology overall in the industry due to its simplicity (Sokovic et al., 2010). In recent years, the effectiveness of the PDCA methodology for quality improvement has been underscored in manufacturing, services, the health care system, and other environments (Nguyen et al., 2020). It enables the creation of multidisciplinary teams for each project, thus bringing together various skills in a single context. However, its simplicity may limit the use of this method in complex projects where threats develop rapidly. The PDCA also fails to monitor the execution phase, not explaining how to perform it or which statistical tools to use. Additionally, relying on multidisciplinary teams can become a weakness as even minimal lack of communication impacts the project (Shypovskyi, 2023).

The DMAIC methodology was initially associated with the Six Sigma, with its task-domain in variation reduction, especially in manufacturing processes. Later, the method was used for more general tasks, such as quality improvement, efficiency improvement, cost reduction, and other pursuits in operations management, and beyond manufacturing in services, healthcare, and other types of operations (Mast & Lokkerbol, 2012). The last four decades have seen a growing trend towards the use of the DMAIC methodology as a strategy for process improvement in manufacturing and services (Aichouni et al., 2021). In this work the DMAIC methodology is considered as a generic problem-solving and improvement approach, while Six Sigma – DMAIC methodology, or in short Six Sigma, is associated with its initial purpose, to eliminate variances in the process to satisfy customers' quality level.

QC story is known as a standardised approach to problem-solving and standardisation, and for many is considered a methodology derived from PDCA, but more detailed. Instead of 4 steps, QC story presents 8 sequential steps: 1 - Problem identification; 2 - Observation; 3 - Analysis; 4 – Action plan; 5 – Action; 6 – Check; 7 – Standardisation; 8 – Conclusion. QC story is widely disseminated and applied in Brazilian enterprises and is known by the acronym of MASP. According to Sousa et al. (2020) the relevance of QC story depends on its ability to achieve efficiency improvement, not only after the project ends but also its results should be maintained over time.

The 8D methodology is an approach typically employed by quality professionals in the automotive industry and other manufacturing. However, it has also been successfully implemented in services. This methodology focuses on the origin of the recurring problems through proper planning and by determining root causes to address potential solutions (Aichouni et al., 2021). According to Zarghami & Benbow (2017), the meticulousness of the 8D methodology requires a level of bureaucracy that delays the resolution of simpler problems. Similar to DMAIC, 8D requires a qualified team for its implementation, which may entail higher costs.

The purpose of TOC is system improvement through the capacity improvement of the bottlenecks of the system. The performance of the entire chain or process is limited by the strength of the weakest link. In production processes, TOC concentrates on the process that slows the speed of product throughput (Jevgeni S. et al., 2015). The summary of this methodology shows that the reduction of waste in the constraint improves lead time and increases product throughput. When the constraint is improved, variation is reduced, and the process reliability is improved (Goldratt, 1990).

Lean thinking methodology is sometimes called lean manufacturing, the Toyota production system or other designations. Lean focuses on the removal of waste, which is defined as anything not necessary to produce a product or service. The implementation of the Lean principles for waste elimination and for improving the operational efficiency in the industries is increasing gaining awareness. Toyota Production System was developed to achieve the highest quality at the lowest cost and with the shortest delivery time, a concept often referred to as muda, or waste reduction (Palhau et al., 2024). The underpinning framework for the successful implementation of Lean principle in any organization is directed by five continuous cycle improvement phases (Womack and Jones, 1996). These are:

1. The first is the specification of value – This involves the identification of the product's value from the market or customer's perspective. Values can be specified for the producer by the market.
2. Identification of the value stream – The identification of the value stream for the product will indicate the types of actions needed to be taken alongside the value stream. This comprises value adding and non-value adding steps that are unavoidable and the ones that can be eliminated. Hence, at this stage, the wasteful steps will be removed from the process.
3. Creation of flow – The identification, specification and mapping of the value stream for a particular product is followed by the creation of flow. This step ensures the continuous flow of work elements flow with nominal queues, rework or stoppages. This will promote the cycle time for the completion of the product manufacturing and the overall manufacturing lead time.
4. Establishment of pull – This is the fourth principle of the Lean approach after the removal of wasteful steps and the creation of flow. At this step, the customers are allowed to pull a product through the process. This is indicative of the organisation's responsive capacity to the needs of the customers.
5. Seeking for perfection – This is the fifth principle of Lean manufacturing which involves the analysis of each process to increase the value, and further eliminate the waste. At this step, the flow is tightened and value is delivered based on the need of the customers.

In addition to the mentioned methodologies, there are other methodologies, sometimes defined within the organizations themselves, mainly in larger organizations, such as the 4Q improvement methodology from ABB company (ABB, 2023); variants of the mentioned methodologies, such as DMAIV - Define, Measure, Analyze, Design, and Validate, derived from DMAIC, but applied to new processes; and methodologies that result from the combination of them, such as Lean – Six Sigma. However, these cases will not be addressed in this work because either they do not assume significance in the bibliographic context, or they can be framed as specific cases of those that have been presented, or they result from the combination of them.

## 3. Comparison Between PI Methodologies

The previous sections were devoted to present and discuss the various types of process improvement methodologies without great depth, because all of them are covered by some important works that explain their applications and the results achieved. However, the comparison between them is not so explained and only few papers have compared some of them. These are the works of: Nave (2002) that compares Six Sigma, Lean and the TOC; Pacheco (2014) that compares and evaluate the possibility of integration between TOC, Lean and Six Sigma; Aichouni et al. (2021) that compares PDCA, DMAIC, 8D and 4Q; Pistilli (2023) that compares Lean, Six Sigma, Lean Six Sigma and PDCA.

To compare the PI methodologies and validate the first hypothesis, Table 1 summarize the methodologies covered in this work, considering the following parameters: Phases; Goal; Focus; Main effects; Application difficulty; Improvement management; Known case studies; and limitations.

**Table 1.** Summary of process improvement methodologies (adapted from Nave, 2002, and Aichioni et al., 2021)

| **Comparison Parameters** | **Process Improvement Methodologies** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **PDCA** | **Six Sigma** | **DMAIC** | **QC Story** | **8D** | **TOC** | **Lean** |
| **Phases** | 1-Plan<br>2-Do<br>3-Check<br>4-Act | 1-Define<br>2-Measure<br>3-Analyze<br>4-Improve<br>5-Control | 1-Define<br>2-Measure<br>3-Analyze<br>4-Improve<br>5-Control | 1-Identify the Problem<br>2-Observe<br>3-Analyze<br>4-Plan the Action<br>5-Act<br>6-Check<br>7-Standardize<br>8-Conclude | 1-Create a team<br>2-Define and describe the problem<br>3-Contain the problem<br>4-Identify root causes<br>5-Choose corrective actions<br>6-Implement and validate corrective actions<br>7- Take preventive Measures<br>8- Congratualate your team | 1- Identify constrain<br>2- Exploit constrain<br>3-Subordinate processes<br>4-Elevate constrain<br>5-Repeat cycle | 1-Identify the product's value<br>2-Identify the value stream<br>3-Create flow<br>4-Establish pull control<br>5-Seek perfection |
| **Goal** | Minimize the process problems | Reduce variation | Minimize the process problems | Minimize the process problems | Minimize the process problems | Manage constrain | Remove waste |
| **Focus on** | Any process Problem (Comprehensive methodology) | Quality variation | Any process Problem (Comprehensive methodology) | Any process Problem (Comprehensive methodology) | Any process Problem (Comprehensive methodology) | System constrains | Process flow |
| **Main effects** | Depends on the problem, but minimize recursive problems;<br>Create dynamics of continuous improvement. | Uniform process output;<br>Less waste;<br>Improved quality.<br>Create dynamics of continuous improvement. | Depends on the problem, but minimize recursive problems;<br>Create dynamics of continuous improvement. | Depends of the problem, but minimize recursive problems;<br>Create dynamics of continuous improvement. | Depends on the problem, but minimize recursive problems;<br>Create dynamics of continuous improvement. | Increased production rate;<br>Less waste;<br>Improved quality;<br>Create dynamics of continuous improvement. | Reduced flow time;<br>Less waste;<br>Improved quality;<br>Create dynamics of continuous improvement. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Aplication dificulty** | Low | Hight | Medium | Medium | Hight | Hight | Medium |
| **Improvement-management** | Operators | Top managers | Middle managers; Operators. | Middle managers; Operators. | Middle managers | Top managers | Middle managers |
| **Known case studies** | Very high | High | Very high | Medium | Medium | Low | Very high |
| **Limitations** | Limited for simple problems; Requires discipline to maintain the multiple cycles. | Time and resources consuming; Trained collaborators; Rigid methodology. | Little detailed; Dependent of the tools employed. | Time consuming; Bureaucratic. | Time consuming; Bureaucratic; Trained collaborators. | Little operator intervention; Trained collaborators; Rigid methodology. | Cultural change; Trained collaborators; Rigid methodology. |

Analyzing Table 1, some conclusions can be drawn, namely, those considered most significant are:

1. The presented methodologies do not have the same phases and are characterized by different outcomes;
2. Three of the methodologies, namely Six Sigma, TOC, and Lean, have specific focuses, while the others are flexible for any process improvement;
3. All of them present, as one of their main effects, the creation of continuous improvement dynamics, which suggests that process improvement in a company should follow a certain methodology. However, this continuous improvement is reactive for all because do not consider a phase that open the possibility for improvements without the existence of a problem;
4. Concerning the application difficulty, PDCA methodology has the lowest degree of difficulty, and it seems to have a positive correlation between the difficulty and the methodologies that have specific focuses, Six Sigma, TOC, and Lean;
5. For the improvement management, it varies from the worker level to the top manager level, and it is linked with the application difficulty of the methodology;
6. Known case studies are higher for the less difficult methodologies;
7. All of them have been validated to some extent because case studies with their implementation are reported in the literature;
8. None of the methodologies include validation of the proposed improvement before its implementation in their phases, which could be considered a limitation for all of them.

The methodologies compared above are quite different but at the same time can be seen as complementary to each other. In spite of that, all of them already were validated in real case studies. This fact could be seen as a constraint for the creation of a new one, or, at the same time, an incentive to perform its development. Additionally, from the analysis conducted in points 3 and 8, it is observed that there is no phase for promoting proactive continuous improvement, and neither for validating the proposed improvement before its implementation. In this way, then, the most logical alternative is to build a new PI methodology, that integrates the advantages of continuous improvement methodologies analyzed, in an integrated and structured way to effectively address process-related issues.

Considering the previous analysis, hypothesis H1 (There are differences between the major PI methodologies and gaps not covered by them) is validated and opens space for the creation of a new one. In light of the above, it is suggested that a new methodology could be developed to mitigate some of the existing gaps. In the next section, this methodology will be presented globally with the acronym of MAPIC - Methodology of Analysis and Process Improvement Completed.

## 4. The Methodology MAPIC

The proposed MAPIC methodology is based on the authors' earlier work on process improvement in Ávila et al. (1999) and their experience gained from participating in various process improvement case studies, for example, in Putnik and Ávila (2015), Ávila et al. (2019), and Silva et al. (2021). MAPIC, recently further detailed in Monteiro (2023), aims to be a flexible methodology for any process problem, triggering proactive continuous improvement, with validation of the improvement proposal before its implementation. In short, completed, in the sense that mitigates the gaps of the other ones. MAPIC is supported by the following eight main steps:

1. Selection of the process aspect to improve;
2. Selection of the products or processes to analyze;
3. Record, synthesis, and analysis of the aspect to improve;
4. Formulation of the improvement plan;
5. Validation of the improvement plan;
6. Scheduling the implementation of the improvement plan;
7. Implementation and control;
8. Final validation of the implementation.

**(1) Selection of the process aspect to improve -** This phase emphasizes the need, before starting any study on process improvement, to first identify which aspect of the process one intends to improve. This activity fits into a proactive philosophy of continuous improvement, where problems are not necessarily identified when starting an improvement project. In summary, the start of an improvement project does not necessarily have to begin with the existence of a problem, as is the case with the methodologies reviewed in the previous section.

**(2) Selection of the products or processes to analyze -** This phase emphasizes the need to select the products or processes on which one intends to improve the aspect identified in the first phase. Typically, undertaking an improvement study on all products is not a good methodology. It is suggested in this phase to study the part of the system that contributes most to the aspect of the process to be improved.

**(3) Record, synthesis, and analysis of the aspect to improve -** This phase emphasizes the need to consider: recording the largest amount of relevant information for the aspect to be improved, its synthesis, and finally its analysis aimed at identifying potential causes. In the process analysis, one should start from the overall process to the specifics of the activities.

**(4) Formulation of the improvement plan -** This phase emphasizes the need to formulate a proposal for an improvement plan based on the results of the analysis from the previous phase and any additional information that may now be necessary, particularly for activities that have been identified as critical. The formulation of the improvement plan can be based on one of the following four basic formulations, or their combination:

- Improvement of critical activities for the aspect of the process to be improved;
- Improvement of resource utilization;
- Improvement of the implementation of productive resources;
- Improvement of the control of production flows.

**(5) Validation of the improvement plan -** This phase emphasizes the need to validate the improvement plan before its implementation. Validation should first validate the intended performance and subsequently, if necessary, the financial performance. In the initial validation, the aim is to assess whether the proposed plan will bring improvements to performance, and if confirmed, financial validation will evaluate whether the investment mainly ensures a payback aligned with the estimated life cycle for the processes under study.

To proceed with performance validation, one must decide how to do it, that is, what type of demonstrator to use. In a brief reference to the ways in which a demonstrator can be built, as mentioned in Figure 1, i.e., the ways in which a system can be studied, we find that we can resort to the system itself or to a model that represents it (simulate).

The validation of the plan may be straightforward if the proposals presented are clearly evident in their potential to improve the system's performance and the costs involved are small, in which case implementation can proceed immediately, even on an experimental basis.

In situations where experimentation on the actual system proves impractical, due to factors such as costs, time, uncertainties, etc., validation can be carried out using different types of models that simulate the real system. Among these models, numerical models, which work by approximation, have proven to be effective and efficient in decision-making. There are several tools that fall under this type of model, including: analysis charts that quantify the expected improvements with the proposed changes; two-handed chart; discrete event simulation or continuous simulation, etc. Of these tools, simulation has been positively affirmed in the study of production systems, with programs designated as simulators, e.g., FlexSim and Arena, being quite powerful and effective for this purpose.

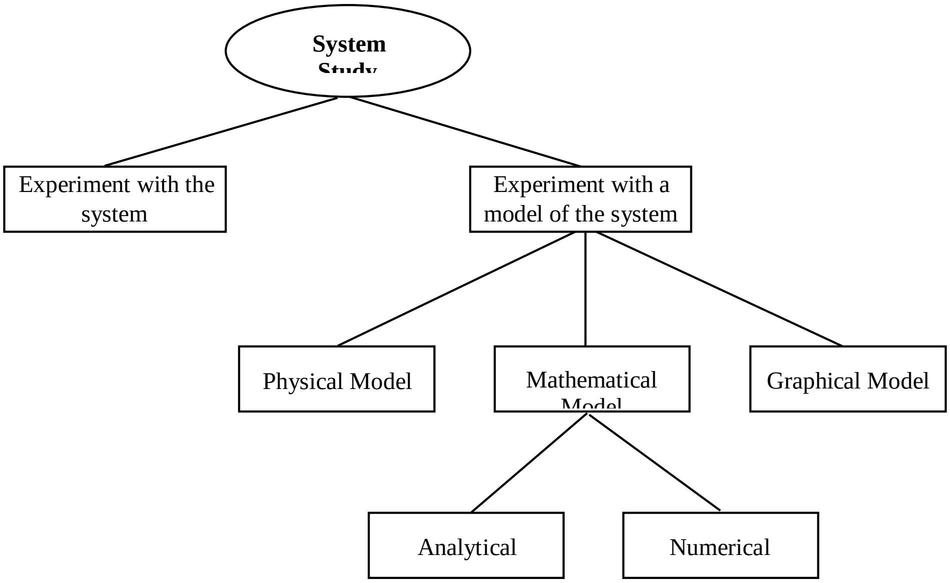


**Figure 1.** Ways to study a system (adapted of Law & Kelton, 1991).

**(6) Scheduling the implementation of the improvement plan -** This phase emphasizes the need to define the schedule for implementing the improvements. The essential elements for proper scheduling of the implementation of an improvement project are: defining objectives; identifying tasks, their responsible parties, and deadlines; allocating resources; effective communication; and risk containment.

**(7) Implementation and control -** This phase emphasizes the need to control the implementation according to the program established earlier. Unexpected events may necessitate adjustments to the implementation program. Monitoring the implementation will lead to adapting the necessary resources, deadlines, and even some changes to the improvement plan may be necessary.

**(8) Final validation of the implementation -** This phase highlights the need to assess whether the actual results achieved are aligned with what was expected. Once validation has been done before implementation, there are unlikely to be major surprises regarding the results achieved. However, there will be differences in results between the two validations, so it will be necessary to understand the causes of these differences and define new indicators for the project's improvement results.

After this presentation of MAPIC, it is important to characterize and compare it with the others presented in the previous section. MAPIC is characterized in Table 2, but some explanations are necessary to understand the classification made, namely:

- The objective is characterized by two possibilities depending on the approach to process improvement. In the case of a proactive approach, which is the main objective of MAPIC, our goal is to improve process performance. In the case of a reactive approach, the objective is to minimize process problems.
- Similarly, to the objective, the focus of MAPIC is also divided. In the case of a proactive approach, the focus is on any characteristic of the process to be improved. In the case of a reactive approach, the focus will be on the process problem.
- Regarding case studies, the recent version of MAPIC, presented in this paper, is being tested for the first time in an industrial environment, so the results are not yet known. However, the first version of MAPIC, by Ávila et al. (2019), had several successful applications in an industrial environment.
- Although not mentioned in the table, the tools/techniques that can support the different phases of MAPIC were not specified. MAPIC was designed to be able to accommodate any tools/techniques that are compatible with the purpose of the respective phase. MAPIC has the flexibility to accommodate any tools regardless of their original philosophy, such as classical Lean tools.

**Table 2.** Summary of the methodology MAPIC.

| Parameters | MAPIC Methodology |
|---|---|
| **Phases** | 1- Selection of the process aspect to improve<br>2- Selection of the products or processes to analyze<br>3- Record, synthesis, and analysis of the aspect to improve<br>4- Formulation of the improvement plan<br>5- Validation of the improvement plan<br>6- Scheduling the implementation of the improvement plan<br>7- Implementation and control<br>8- Final validation of the implementation |

| | |
|---|---|
| **Goal** | Improve the process Performance<br>or<br>Minimize the process problems |
| **Focus on** | Any process feature to improve<br>or<br>any process problem<br>(Comprehensive methodology) |
| **Main effects** | Depends of the problem, but can:<br>- Improve critical activities for the process performance;<br>- Improve the use of resources;<br>- Improve the production layout;<br>- Improve the control of the production flows;<br>- - Create dynamics of continuous improvement in a proactive way |
| **Aplication difi-culty** | Medium |
| **Improvement-management** | Middle managers |
| **known case stud-ies** | Not known in this final version, but few in the initial version |
| **Limitations** | Time and resources consuming;<br>Cultural change;<br>Trained collaborators. |

Comparing MAPIC with the other methodologies, it can be said that it stands out for the following factors:

- MAPIC is a methodology that will join the group of comprehensive methodologies, without a specific focus on the process characteristic to be addressed.
- MAPIC demonstrates, from its first phase, a proactive continuous improvement approach, different from those analyzed, which are based on a reactive continuous improvement approach.
- While MAPIC validates the improvement proposal before its implementation, the other methodologies are silent on this matter.

Given the above, the research question H2 (A new PI methodology may mitigate the gaps identified in the existing PI methodologies) is considered theoretically validated, because, MAPIC presents differentiating elements from other methodologies and adds new functionalities to mitigate the existed gaps, that could positively increase the support for the application of process improvements in companies.

## 5. Conclusion

Process improvement methodologies are important for triggering effective and efficient improvements in companies. However, there are some PI methodologies with different approaches and independently of the methodology applied, sometimes the improvement results are not the desired for the companies. Following the above, this work addressed the problem of compare the most important PI methodologies and to propose a new methodology with a broader spectrum of application and mitigating the gaps found in the other methodologies. In this sense, two research questions were formulated: H1 - There are differences between the major PI methodologies and gaps not covered by them; H2 - A new process improving methodology may mitigate the gaps identified in the existing PI methodologies.

After the literature review in section 2, the validation of the research question H1 was done in section 3 with the comparison of the

PI methodologies most mentioned in the literature. The main results of this comparison had shown that there are significant differences between them, there is no phase for promoting the proactive continuous improvement, and neither for validating the proposed improvement before its implementation. These results also opened space for the creation of the new PI methodology, the MAPIC. MAPIC was then presented in section 4 and compared with other methodologies and mainly standing out for the following: (1) MAPIC is a methodology that will join the group of comprehensive methodologies, without a specific focus on the process characteristic to be addressed; (2) MAPIC demonstrates, from its first phase, a proactive continuous improvement approach, different from those analyzed, which are based on a reactive continuous improvement approach; MAPIC validates the improvement proposal before its implementation, while the other methodologies are silent on this matter. In line with the MAPIC presentation and its comparison with the other PI methodologies, the research question H2 is considered theoretically validated, because, MAPIC presents differentiating elements from other methodologies and adds new functionalities to mitigate the existed gaps.

In the future, it is intended to allocate a set of tools/techniques to support the various phases of MAPIC and present the results of its implementation in several case studies, which will validate the methodology to some extent in practical terms. For this practical validation, the MAPIC is already being applied in a first case study and the results will be presented in further work. With this work, it is also hoped that the business community will have another methodology at its disposal, one that minimizes identified gaps and that enhances good results in supporting projects for continuous improving the production process.

**Acknowledgment:** This work was financed by national funds through the Portuguese funding agency, FCT—Fundação para a Ciência e a Tecnologia, within project LA/P/0063/2020.

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