Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/SA6.20250172
Published: May 12, 2025

Development of a Framework to Support Tool Selection in the DMAIC Method, in Lean Six Sigma

Evelyn Amanda de Abreu Lopes Ramos
Professor of Production Engineering | Master's student
FACENS University | University of Sorocaba – UNISO
Sorocaba, Sao Paulo, Brazil
evelyn.ramos@facens.br

Rogério Augusto Profeta
Advisor and Rector of the University of Sorocaba – UNISO
University of Sorocaba – UNISO
Sorocaba, Sao Paulo, Brazil
rogerio.profeta@prof.uniso.br

Abstract

The DMAIC (Define, Measure, Analyze, Improve, and Control) method is the main method of the Lean Six Sigma methodology, focused on solving problems where the root cause is unknown. Although DMAIC has a well-defined structure, many professionals — especially those who are new to Lean Six Sigma — face difficulties in selecting the appropriate tools for each stage, due to the number of options available. This research aimed to develop the "Belt Flow Framework", a decision support model developed especially to guide professionals in selecting the appropriate tools for each stage of the DMAIC method, according to the characteristics of each process improvement project. The methodology chosen was the construction of theory from multiple cases, proposed by Eisenhardt (1989), where six Lean Six Sigma professionals contributed through a structured questionnaire, allowing intra-case and inter-case analyses. As a result, a framework was developed, which was initially developed in a flowchart format and later implemented in a digital and interactive application, allowing users to logically navigate and identify which tools to apply at each stage of DMAIC. The results demonstrated high acceptance by participants, who classified the Framework as clear, applicable and useful in reducing uncertainty in tool selection. This study offers a theoretical and practical contribution to the Lean Six Sigma field, offering a structured, validated and accessible solution to a common challenge in the execution of DMAIC projects.

Keywords
Lean Six Sigma, DMAIC, Framework, Production Engineering and Process improvement.

1. Introduction
The search for process improvement is growing more and more, due to the increase in business competitiveness, and with this the search for methodologies that work in this area is also growing. Lean Six Sigma is a globally recognized methodology for process improvement projects, and the main method associated with Lean Six Sigma is the DMAIC method (Define, Measure, Analyze, Improve and Control).

For each stage of the DMAIC method, there is a very large number of associated tools, which requires extensive knowledge from the professionals who work with the method, and the appropriate choice of these tools is crucial to the success of the projects.

Many professionals who work in the Lean Six Sigma area face difficulties in selecting which tools to use in their projects, especially professionals who are new to the area, which can result in the inappropriate choice of tools or even in their non-use, compromising the effectiveness of the analyses and proposed solutions.
Based on this problem, this study proposes the development of a framework that assists professionals in selecting appropriate tools for the different stages of the DMAIC method, considering the specific characteristics of each improvement project.

1.1 Objectives
The overall objective of this study was to develop a framework to assist in identifying appropriate tools to be used in each stage of the DMAIC method, considering the specific characteristics of each process improvement project. In addition, this study had the specific objective of demonstrating, through the perception of professionals, the potential applicability of the Framework in guiding the choice of appropriate tools associated with DMAIC.

2. Literature Review
2.1 Lean Six Sigma
Oliveira (2024) explains that the origins of Lean Manufacturing go back to the TPS (Toyota Production System) and that the term "Lean Manufacturing" first appeared in the book "The Machine That Changed the World" written by James P. Womack and Daniel T. Jones, in 1990. The Toyota Production System was conceived and its implementation began shortly after World War II, where the main difference of the TPS was the focus on reducing waste (Ohno 1997).

Ohno (1997) classifies waste into 7 types: a) Overproduction; b) Waiting; c) Transportation; d) Excessive processing; e) Inventory (stock); f) Movement. Some current authors such as Oliveira (2024) include, in addition to the 7 wastes identified by Ohno, the eighth waste, intellectual waste, or waste of the misuse of human capital, which is related to the waste of knowledge and skills of employees.

Jones et al. (2004) comment that lean thinking is essential for the principles of Lean Manufacturing to be put into practice. Furthermore, the authors define Lean Manufacturing as a way of specifying value, aligning in the best sequence the actions that have been identified as actions that create value and carrying out these actions without interruption, seeking a way to carry out activities in an increasingly effective way.

Brenig-Jones and Dowdall (2023) comment that Six Sigma focuses on reducing process variability, resulting in increased product quality. Werkema (2011) describes that Six Sigma emerged at Motorola in 1987, at a time when Motorola was going through complicated business situations and needed to reduce its costs to be able to face the strong competitors that were emerging at the time.

Werkema (2011) states that over the years, it has become natural for companies that use Lean Manufacturing to seek to integrate it with Six Sigma, with the aim of taking advantage of the benefits of both methodologies. This integration was called Lean Six Sigma. Oliveira (2024) says that this integration between Lean Manufacturing and Six Sigma gave rise to one of the most sought-after methodologies in the corporate world: Lean Six Sigma, a unique methodology capable of providing an efficient approach for organizations, increasing productivity and reducing waste and process variability, adding value to the customer through process improvement.

2.1.2 The DMAIC method
The DMAIC method is the main method used within the Lean Six Sigma methodology, and can be classified as a structured method for identifying, analyzing and solving problems in processes, especially when the root cause of the process is unknown, being capable of providing a line of logical reasoning, being divided into five stages: Define, Measure, Analyze, Improve and Control (Oliveira 2024).

Werkema (2013) classifies the objectives of each stage of the DMAIC method as: Define – Accurately define the scope involved in the project; Measure – Determine the focus of the problem; Analyze – Determine the root causes of the problem; Improve – Propose, evaluate and implement solutions to address the root cause of the problem; Control – Ensure that gains are maintained in the long term. While Pyzdek and Keller (2010) assign the following objectives to each stage of the DMAIC method: D – Define: Define the project goals. M – Measure: Measure existing processes. A – Analyze: Analyze the processes to identify ways to eliminate the gap between the current process performance and the desired goal, seeking the root cause of the problem. I – Improve: Implement actions to improve the process. C – Control: Develop ways to control the new process.

There is a wide variety of tools associated with each of the steps of the DMAIC method, which, although not exclusive to the DMAIC method itself, are used according to the needs of each process improvement project in the context of Lean Six Sigma, contributing to the DMAIC method being recognized as a systematic, data-driven approach aimed at achieving strategic results in organizations (Werkema 2013).

Oliveira (2024) attributes the following activities to the Define stage: Defining the project theme; Defining the project scope; Defining the team; Determining the KPIs (Key Performance Indicators); Defining the goal; Elaborating the schedule and Defining the stakeholders. The recommended tools in the Define stage are: Thinking Map; Project Charter; Six Sigma Metrics; Sequential Chart; Control Chart; Time Series Analysis; Economic Analysis; Lean Metrics; Voice of the Customer; SIPOC and Value Stream Mapping (VSM) (Werkema 2013).

The activities associated with the Measure stage are: Analysis of the reliability of the project database; Search for new data; Data stratification; Analysis of data history; Analysis of the measurement system (MSA); Analysis of process performance (Oliveira 2024). Among the tools recommended for use in the Measure stage of the DMAIC method, the following stand out: Kaizen; Mathematical calculation; Multivariate analysis; Six Sigma metrics; Capability indices; Boxplot; Histogram; Time Series Analysis; Control Chart; Sequential Chart; Lean metrics; Value Stream Mapping (VSM); Pareto diagram; Sampling; Checklist; Data Collection Plan; Stratification; and Evaluation of Measurement/Inspection Systems (Werkema 2011).

Oliveira (2024) associated the following activities in the Analyze stage of the DMAIC method: Identifying root causes; Proving root causes through facts and data; Using the collected data for quantitative and qualitative analyses; Performing statistical analyses to prove root causes. Pyzdek and Keller (2010) highlight that in the "Analyze" stage of the DMAIC method, tools such as: Cause and Effect Diagram; Statistical inference techniques; Hypothesis testing; Analysis of variance; Nonparametric methods; Logistic regression; DOE (Design of Experiments); Correlation and regression analysis; Boxplot; Spaghetti Diagram; and Value Stream Mapping (VSM) can be used.

In the Improve stage, it is recommended to use tools such as: Brainstorming; Relationship Diagram; Prioritization Matrix; Affinity Diagram; Value Stream Mapping (VSM); Lean Metrics; Setup Reduction; Matrix Diagram; FMEA; Stakeholder Analysis; Simulation; Kaizen; Kanban; 5S; TPM; Poka-Yoke; Visual Management; Evolutionary Operation (EVOP); Hypothesis Testing; 5W2H; Tree Diagram; Operational Testing; Market Testing; Gantt Chart; PERT / CPM; Decision Making Process Diagram (PDPC) (Werkema 2011). Oliveira (2024) comments that the following activities are associated with the Improve stage: Proposing, prioritizing and executing solutions to address the identified root causes; Collecting results and verifying the impacts of the improvements implemented; Measuring financial gains after implementing the action plan.

While in the Control stage, Oliveira (2024) comments that the associated activities are: Monitoring the results after implementing the improvements; Creating control mechanisms that support the results obtained. Werkema (2013) recommends the following tools in the control stage: Value Stream Mapping (VSM – Future); Control Chart; Histogram; Capability Indices; Measurement/Inspection System Assessment; 5S; TPM; Poka-Yoke; Visual Management; Manuals; Meetings; Lectures; Pareto Diagram; Six Sigma Metrics; Value Stream Mapping (VSM); Lean Metrics; Standard Procedures; On the Job Training (OJB); Data Collection Plan; Sampling; Auditing of Standards Usage; Anomaly Reports; Out of Control Action Plan (OCAP).

Due to the large number of tools associated with each step of the DMAIC method, Lean Six Sigma professionals often have doubts about which tools they should use, especially in their first projects. Although there is a vast literature describing the set of tools applicable in each step, there are no scientific studies in the literature developed to create a clear framework that can serve as a guide to assist Lean Six Sigma professionals in the correct selection of these tools, which continue to be crucial for the success of projects. An inadequate choice can compromise data analysis, generate erroneous conclusions and, consequently, impact the project results. Therefore, it is essential that professionals involved in Lean Six Sigma projects have means to assist them in making decisions regarding the most appropriate tools for each situation, such as the framework proposed in this study.

3. Methods

The method used in this study was theoretical construction based on case studies, as suggested by Eisenhardt (1989). This method was chosen because it is aligned with the objective of developing a framework to assist in identifying tools to be used in each stage of the DMAIC method, according to each process improvement project. The use of multiple cases, advocated by Eisenhardt (1989), allowed us to explore the different perspectives of professionals on the difficulties in selecting tools throughout the DMAIC method, favoring a comparative analysis between different contexts. The methodological steps adopted are described below:

Step 1 - Selection of participants: The participants selected for the research were professionals with knowledge of Lean Six Sigma, specifically about the DMAIC method, regardless of their level of knowledge. Intentionally, a diversity of profiles was chosen, selecting professionals who work in different sectors. It is worth noting that the method proposed by Eisenhardt (1989) requires the use of 4 to 10 cases, and the author argues that this is an ideal number due to the level of detail that must be carried out within and between cases. Therefore, in this study, 6 cases were chosen.

Step 2 - Construction of the Belt Flow Framework: A structured framework was developed to assist in identifying appropriate tools to be used in each stage of the DMAIC method, according to each process improvement project. The proposed framework was developed based on a theoretical and practical review of the DMAIC method and its associated tools. The "Belt Flow Framework" was structured to act as a guide to support decision-making, offering a visual and sequential logic to guide the choice of tools in each phase of DMAIC. Its development also considered aspects of clarity, practical applicability and flexibility for different levels of knowledge in Lean Six Sigma.

Step 3 - Preparation of the interview script: A semi-structured questionnaire containing closed and open questions was developed, organized to understand the professionals' perceptions about the use of the DMAIC method and the usefulness of a structured framework to identify which tools to use in each stage of the DMAIC method. The questionnaire was structured as follows: a) Initial information and acceptance of the Free and Informed Consent Form (FICF); b) Identification of the participant's profile; c) Difficulties faced in applying the DMAIC method; d) Perceptions about the steps and tools associated with the method; e) General perceptions and suggestions; f) Evaluation of the proposed framework.

Step 4 - Conducting the interviews: The questionnaire was sent by email to each participant, who was able to answer each of the questions during the month of March 2025. In addition, the participants had access to the "Belt Flow Framework" and were able to perform a critical analysis and then share their perceptions about the clarity, applicability and practical contributions of the proposed framework.

Step 5 - Quantitative and qualitative analysis of the responses: The responses were analyzed to identify patterns of perception, criticisms, suggestions for improvement and possible adaptations of the framework to different contexts. The analysis also sought to understand whether the participants identified any gaps or practical difficulties related to the choice of tools in the DMAIC method, thus validating the need for a structured framework such as the "Belt Flow Framework". This approach allowed to assess the alignment of the framework with professional practice and identify opportunities for its improvement.

Step 6 - Summary of perceptions for framework evaluation: Based on the analysis of the responses, the perceptions were organized into categories that reflect the main points highlighted by the participants regarding the applicability, clarity, practical usefulness and suggestions for improvement of the "Belt Flow Framework". Through this summary, it was possible to consolidate a structured evaluation of the perceptions about the framework, allowing reflections on its adaptation and evolution to different organizational contexts and levels of maturity in Lean Six Sigma.

4. Data Collection

In order to collect the data in the best possible way, it was decided to send the semi-structured questionnaire by email to each of the six research participants, remembering that the selected professionals had different levels of experience with Lean Six Sigma.

The questionnaire consisted of closed and open questions, organized into sections that covered everything from the participant's profile to the evaluation of the proposed framework, as presented in chapter 3, step 3. Before the participants answered the "Evaluation of the proposed framework" section, they had access to the Belt Flow Framework and were able to interact with its content freely, without a time limit, analyzing in detail how the proposed framework worked.

The collection sought to capture both quantitative perceptions (through evaluation scales) and qualitative perceptions (through open-ended responses), allowing for a more in-depth analysis of individual perceptions and subsequent comparison between the perceptions of all research participants.

The participants were numbered from 1 to 6 in this article and the order of participants is the same in all the results presented, thus facilitating understanding for readers.

5. Results and Discussion

This chapter presents the results obtained from the responses to the questionnaire sent to the selected professionals. The main focus of this study is the Belt Flow Framework, a structured framework developed to serve as a structured guide to support the selection of tools throughout the stages of the DMAIC method.

The proposed framework was developed based on a practical analysis of the main difficulties faced by Lean Six Sigma professionals during improvement projects, organizing the most appropriate tools for each stage of the DMAIC method in a logical and accessible way. The “Belt Flow Framework” was developed using the “Jotform.com” website, which allows the creation of “No-Code” app, that is, without the need to program, allowing the user to navigate through the DMAIC stages, answering guiding questions and thus viewing the most appropriate tools for the context of their project. Figure 1 presents a visual representation of the Belt Flow Framework:

Figure 1. Belt Flow Framework

In addition to identifying the tools to be used in each stage of the DMAIC method, through the Belt Flow Framework, the user can also access and download models of the main tools associated with DMAIC. The Belt Flow Framework can be accessed through the QR Code shown in Figure 2 or through the hiperlink: https://app.jotform.com/250746193383664.

Figure 2. QR Code to access Belt Flow Framework

The results obtained in relation to the participants' perception of the need for this type of framework are presented below, and, finally, the evaluation of the Belt Flow Framework.

5.1 Numerical Results

In order to understand the professionals' perception of the difficulties in choosing the appropriate tools during the steps of the DMAIC method, participants were asked about their level of experience and which step they considered to be the most challenging. In addition, the analysis of the data collected from the six study participants allowed us to identify patterns regarding the difficulties faced in applying the DMAIC method, as can be seen in Table 1.

Table 1. Participants' responses

PARTICIPANT	EXPERIENCE LEVEL	MOST CHALLENGING STAGE	HAVE YOU EVER CHOSEN INAPPROPRIATE TOOLS OR HAD DOUBTS ABOUT HOW TO APPLY THEM?
Participant 1	Advanced	Analyze	Yes
Participant 2	Advanced	Analyze	Yes
Participant 3	Advanced	Measure	Yes
Participant 4	Only theoretical	Define	No
Participant 5	Advanced	Analyze	Yes
Participant 6	Advanced	Measure	Yes

The data revealed that this difficulty is not restricted to the professional's level of experience, being reported by both beginners and experienced professionals in the Lean Six Sigma area.

During the analyses carried out, it was observed that all participants who have practical experience with applying projects using the DMAIC method have already encountered situations in which they used incorrect tools or had doubts regarding the choice of the tool. The only participant who did not present relevant difficulties had only theoretical experience with Lean Six Sigma, which explains why he did not present difficulties in choosing the appropriate tools to be used in each stage of the DMAIC method.

The “Analyze” step was widely identified as the most challenging, followed by the “Measure” step. Most participants reported the lack of a structured guide as a cause of insecurity and rework in the project phases. Furthermore, it can be observed that 100% of the participants agreed that the variety of tools available in the DMAIC method can lead to incorrect choices and compromise the project results.

Table 2 shows the scores given by research participants in relation to the difficulties in choosing tools by stage of the DMAIC method, on a scale of 1 to 5, where 1 represents no difficulty and 5 represents a lot of difficulty.

Table 2. Difficulties in choosing tools by stage of the DMAIC method

PARTICIPANT	DEFINE (1-5)	MEASURE (1-5)	ANALYZE (1-5)	IMPROVE (1-5)	CONTROL (1-5)
Participant 1	2	3	5	2	3
Participant 2	3	3	5	4	3
Participant 3	3	5	5	3	2
Participant 4	5	4	3	4	4
Participant 5	4	2	3	2	2
Participant 6	5	5	4	3	3

Table 2 presents the scores given by each participant to the perceived difficulty in choosing tools at each stage of the DMAIC method, on a scale of 1 (little difficulty) to 5 (very difficult). The "Analyze" stage had the highest average difficulty (4.17), being rated as the highest by three of the six participants. The statistical and interpretative nature of this stage makes it a critical point for the application of the method.

The "Control" stage was considered the least challenging, with an average of 2.83, followed by "Improve" (3.00), "Define" and "Measure" (3.67). The "Measure" stage showed more marked variations, with some participants assigning maximum scores (5) and others, minimum scores (2), suggesting that the difficulty may depend strongly on previous experience or the area of application (services vs. manufacturing, for example).

In addition, participants answered two other important questions: "From 1 to 5, what is the impact on the incorrect choice of tools due to the number of tools associated with the DMAIC method?" and "In your opinion, would a framework facilitate the use of DMAIC?", the answers can be seen in table 3.

Table 3. Perception of the impact of the variety of tools and the usefulness of a framework

PARTICIPANT	FROM 1 TO 5, WHAT IS THE IMPACT ON THE INCORRECT CHOICE OF TOOLS DUE TO THE NUMBER OF TOOLS ASSOCIATED WITH THE DMAIC METHOD?	IN YOUR OPINION, WOULD A FRAMEWORK FACILITATE THE USE OF DMAIC?
Participant 1	4	Yes
Participant 2	5	Yes
Participant 3	4	Yes
Participant 4	5	Yes
Participant 5	4	Yes
Participant 6	5	Yes

As shown in Table 3, all respondents gave high scores (4 or 5) to the negative impact of the difficulty of choosing caused by the large number of tools associated with DMAIC. Furthermore, 100% of participants stated that, in their opinion, a framework would facilitate the application of the method, reinforcing the perception of the need for a structured support instrument. These results, validate the existence of an operational gap in the DMAIC method: the absence of a simple, structured and functional tool that helps professionals in the appropriate choice of tools to be used in each stage of the DMAIC method, according to each process improvement project.

5.2 Graphical Results

To deepen the understanding of the data and facilitate the visualization of the identified patterns, graphs were created representing the main variables analyzed in the stage of proving the need for the Belt Flow Framework.

Figure 3 shows how often each step of the DMAIC method was considered the most challenging by participants, segmented by experience level.

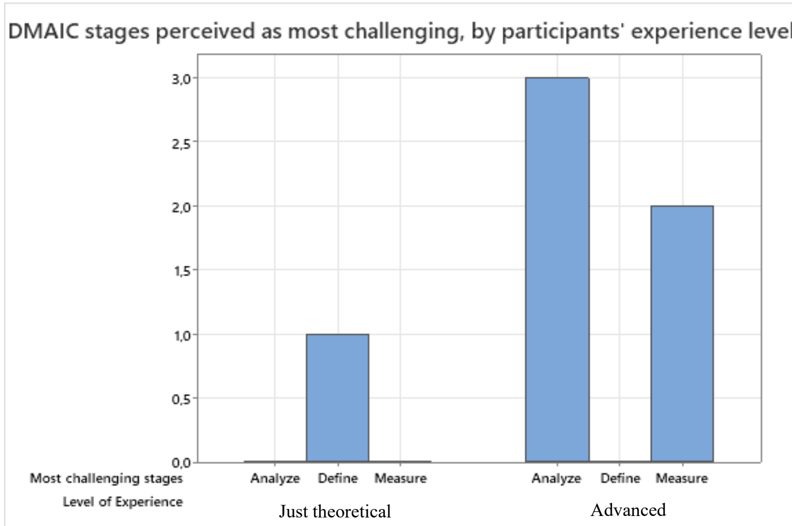

Figure 3. DMAIC stages perceived as most challenging, by participants' experience level

It can be seen that the "Analyze" step was indicated as the most challenging by three of the six respondents, reflecting the need for statistical knowledge and analytical interpretation. The "Measure" and "Control" steps were also mentioned, although less frequently. No participant indicated "Improve" as the most difficult step. Figure 4 shows a boxplot illustrating the distribution of perceived difficulty levels for each DMAIC stage.

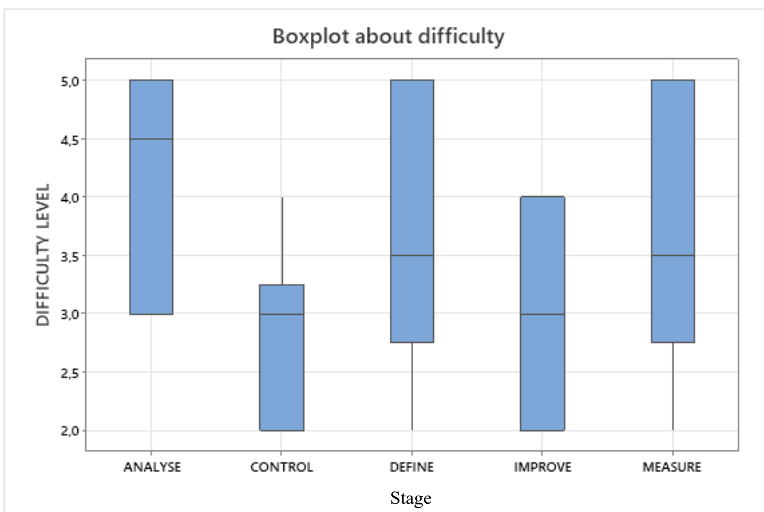

Figure 4. Distribution of perceived difficulty levels across DMAIC stages

It can be seen that the "Analyze" stage had the highest median, with moderate variation, which suggests a consensus among participants regarding its complexity. The "Define" and "Measure" stages showed a greater range of responses, indicating that the perception of difficulty can vary significantly among respondents, possibly influenced by the level of individual familiarity with the tools applicable to these stages. On the other hand, the "Control" stage demonstrated the lowest median and the lowest variation, suggesting that participants have greater mastery and confidence in relation to the tools commonly used in this stage of DMAIC.

5.3 Validation

In order to validate the proposed Belt Flow Framework, participants were invited to analyze the Framework and answer questions related to it, assigning scores from 1 to 5, using a Likert scale, ranging from "Totally Disagree" (1) to "Totally Agree" (5). Figure 5 shows the responses provided by participants regarding clarity, applicability in projects and reduction of difficulties.

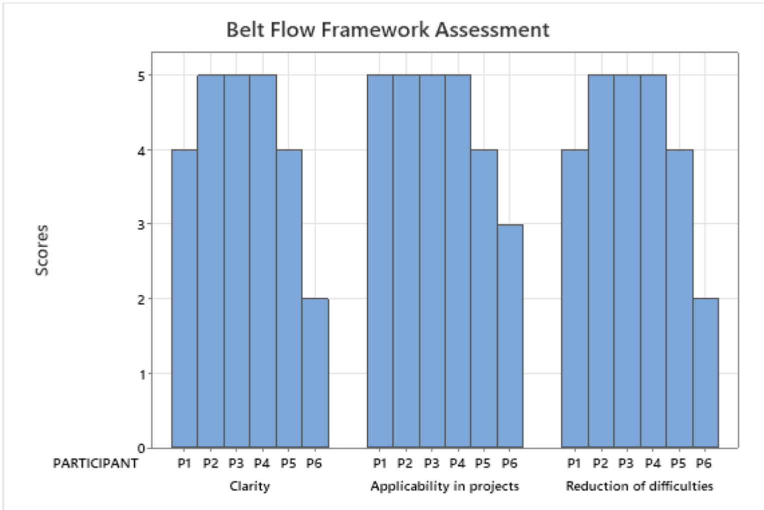

Figure 5. Belt Flow Framework Assessment

It is noted that 83.33% of the participants gave scores of 4 or 5 in all three evaluation criteria, as can be seen in Figure 5. The highest levels of agreement were observed in the item related to applicability, while the criteria "reduction of difficulties" and "Neediness" presented slightly greater variability, with one participant giving a lower score. Even so, the overall assessment indicates that the framework was perceived as a valuable and promising tool to support the DMAIC process.

It is worth noting that despite the scores given by participant 6, he highlighted the methodological clarity and organization as positive points of the framework, emphasizing that he had no difficulties in interpreting or applying the method.

In addition to the evaluation based on the specific criteria presented in Figure 5, participants were also asked to assign a recommendation score (from 0 to 10) regarding the use of the Belt Flow Framework by other professionals working on Lean Six Sigma projects and the DMAIC method, as can be seen in Figure 6:

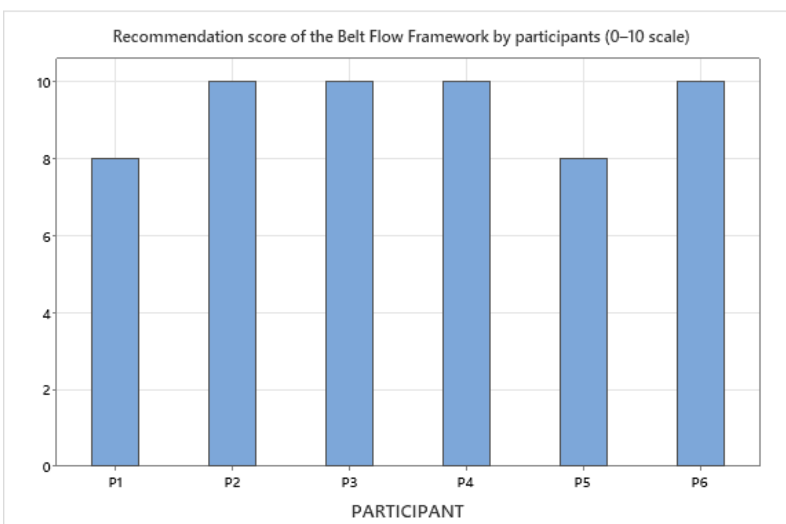

Figure 6. Recommendation score of the Belt Flow Framework by participants (0–10 scale)

As shown in Figure 6, participants were also asked to assign a recommendation score (from 0 to 10) to the Belt Flow Framework. Four of the six gave it the maximum score (10), while the remaining two gave it a score of 8 — which is also considered a high score. The absence of low scores reinforces the perception that the framework is well accepted and considered a relevant and useful solution for professionals working in the Lean Six Sigma area and with the DMAIC method. This positive evaluation confirms the relevance of the proposed framework and strengthens its positioning as a valuable resource to guide the identification of appropriate tools to be used in each step of the DMAIC method, according to each process improvement project.

5.4 Proposed Improvements

Participants were also able to suggest improvements that could increase the applicability and effectiveness of the Belt Flow Framework.

The following points were mentioned for improvement:
a) inclusion of an explanatory video on how to use the Framework for new users;
b) inclusion of a back button on the pages;
c) inclusion of practical examples for each tool presented;
d) defining the type of problem (whether it is administrative or manufacturing, for example, to direct the tools).

The suggestions presented will serve as a basis for updates to future versions of the framework, contributing to its continuous improvement and ensuring greater alignment with the needs of professionals at different levels of experience with Lean Six Sigma and the DMAIC method.

6. Conclusion

This study aimed to develop and validate the Belt Flow Framework, an application designed to support the selection of tools in the different stages of the DMAIC method, with a focus on practical applicability in continuous improvement projects using the Lean Six Sigma methodology. Based on the perception of professionals with different levels of experience in Lean Six Sigma, it was possible to confirm that the appropriate selection of tools still represents a real challenge in project management, especially in the "Analyze" and "Measure" phases.

The results indicated that the Belt Flow Framework was well evaluated in terms of clarity, applicability and usefulness, in addition to being widely recommended by participants. The suggestions for improvement collected also reinforced interest in the framework and pointed out ways for its future improvement, such as the inclusion of practical examples, interactive resources and initial usage guidelines.

As a practical contribution, the Belt Flow Framework proves to be a promising tool to support professionals in decision-making throughout the DMAIC method, reducing uncertainty and promoting greater fluidity in project execution. From a theoretical point of view, the study advances the discussion on how to structure instruments that connect methodology and practice in continuous improvement environments.

For future studies, it is suggested that the improvements suggested by the research participants be applied and that the Belt Flow Framework be applied to real projects, making it possible to obtain practical and comparative results. It would also be interesting to increase the number of samples selected for validation.

References

Brenig-Jones, M. and Dowdall, J., Lean Six Sigma For Dummies, 1rd Edition, Alta Livros, Rio de Janeiro, 2023.

Eisenhardt, K., *Building theories from case study research*, The Academy of Management Review, vol. 14, no. 4, pp. 532–550, 1989. Available: http://www.jstor.org/stable/258557. Accessed on May 5, 2025.

Jones, D., Ross, D. and Womack, J., *The machine that changed the world*, 1st Edition, Elsevier, Rio de Janeiro, 2004.

Ohno, T., *The Toyota production system: beyond large-scale production.* 1st Edition, Bookman, Porto Alegre, 1997.

Oliveira, T., *Lean Six Sigma Practical Guide: black belt*, 1st Edition, Atlas, Barueri, 2024.

Pyzdek, T. and Keller, P., *The Six Sigma Handbook*: *A Complete Guide for Green Belts, Black Belts, and Managers at All Levels,* 3rd Edition, McGraw-Hill, Nova York, 2010.

Werkema, C., *Questions and Answers About Lean Six Sigma,* 2rd Edition, GEN Atlas, Rio de Janeiro, 2011.

Werkema, C., *PDCA and DMAIC methods and their analytical tools,* 1rd Edition, GEN Atlas, Rio de Janeiro, 2013.

Biographies

Evelyn Amanda de Abreu Lopes Ramos is a professor of Production Engineering at FACENS, Sorocaba, São Paulo, Brazil. She's a student a Master's degree in Technological and Environmental Processes from UNISO; a postgraduate degree in Lean Six Sigma from FACENS (2019); She's a Production Engineer from FACENS (2016); and is also a Master Black Belt in Lean Six Sigma. She has experience in consulting projects for manufacturing and service companies, supporting the implementation of Lean Six Sigma methodologies and ISO 9001 standards.

Dr. Rogério Augusto Profeta is Dr. Rogério Augusto Profeta is a Current Rector of the University of Sorocaba. Graduated in Business Administration from the Faculty of Accounting and Administrative Sciences of Sorocaba (FACCAS - 1984), Specialization in Production and Materials Management (FACCAS - 1986), Specialization in Industrial Administration (FCAV - USP 1987), Master in Administration from the Pontifical Catholic University of São Paulo (1995) and Doctorate in Administration from the University of São Paulo (2003). Specialization in Education (Universidade Positivo (2014). He worked in large multinational companies in Sorocaba (J I Case - 1982 to 1986; Moto Peças - 1986 to 1991 and YKK Zíper - 1991 to 1996). He began his academic career in 1988. He was the Institutional Representative of Uniso at the Federation of Industries of the State of São Paulo, Sorocaba region (until 2009). He was a Visiting Professor at the Methodist University of Piracicaba and Visiting Professor - FATEC - Sorocaba - Paula Souza Foundation, participated in Research Projects funded by the São Paulo State Research Support Foundation - FAPESP. He has experience in the area of Administration, with an emphasis on Production and Logistics Administration, working mainly on the following topics: production, logistics, strategy, quality, productivity, innovation and just in time. He conducts research in the area of Didactics, particularly focused on Higher Education and Personnel Training in a corporate environment. He proposed the Focused Team-Based Learning (AFbE) methodology in the Training of Multipliers. He currently teaches classes on "Creativity and Innovation" in the Master's and Doctorate Program in Technological and Environmental Processes at Uniso.