Kata Thinking management model as a tool to enhance continuous improvement capabilities in maintenance operations

Modelo de gestión Kata Thinking como herramienta para potenciar las capacidades de mejora continua en operaciones de mantenimiento

Modelo de gestão Kata Thinking como ferramenta para aumentar capacidades de melhoria contínua nas operações de manutenção

Hernan Andres Amaya Gonzalez[1]
Yeisson Alexis Rincon Cuta[2]
Jennifer Astrid Duarte Alarcon[3]

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1 Investigador, Maestría de Logística Aeronáutica, Escuela de posgrados FAC, Colombia
Email: hamayagonzalez@gmail.com
ORCID: https://orcid.org/0000-0002-9555-0317
CvLAC ID: 1026555983

2 Investigador, Maestría de Logística Aeronáutica, Escuela de posgrados FAC, Colombia
Email: yeisson.rinconc@epfac.edu.co
ORCID: https://orcid.org/0000-0002-5086-3985
CvLAC ID: 79977253

3 Investigador, Maestría de Logística Aeronáutica, Escuela de posgrados FAC, Colombia
Email: jennifer.duarte@epfac.edu.co
ORCID: https://orcid.org/0009-0002-1194-7358
CvLAC ID: 1013582260

Abstract

Introduction: This article is the result of a research project conducted by the Colombian Aerospace Force (FAC) during 2022 and 2023 as part of its ongoing pursuit of cutting-edge knowledge management. The study focuses on improving its management model, contributing to the continuous enhancement of maintenance in the aeronautical sector.

Problem: Lessons Learned, as a tool for preventing unwanted events, has been widely discussed due to the high recurrence of such events. This recurrence indicates that Lessons Learned are not being effectively utilized.

Objective: This document establishes a baseline aimed at strengthening organizational performance by integrating Toyota Kata principles into the Lessons Learned methodology.

Methodology: The integration of the Kata model with the Lessons Learned methodology was conducted by identifying common elements. This integration was then implemented using the Improvement Kata and the Coaching Kata.

Results: The study found that the Lessons Learned process consists of three stages that align with the stages of the Kata model. Additionally, a pattern of recurring Lessons Learned was identified in three key areas. Based on these findings, an application guide for the Kata-Lessons Learned model was developed to address these recurrences.

Conclusion: The proposed baseline enables the effective application of the Kata model within the Lessons Learned methodology. The future adoption of this integrated model will contribute to the continuous improvement of the industry.

Originality: This research provides practical guidance on incorporating a modern management model into the maintenance sector.

Limitations: The Kata-Lessons Learned model must be tested in operational settings to validate its effectiveness.

Keywords: Coaching Kata; Improvement Kata; Lessons Learned; FAC; Toyota Kata; Maintenance.

Resumen

Introducción: Este artículo fue producto de un proyecto de investigación de la Fuerza Aeroespacial Colombiana durante los años 2022 y 2023, en su constante búsqueda de la vanguardia en la gestión del conocimiento, desarrolla mejoras a su modelo de gestión contribuyendo a la mejora continua del mantenimiento en el sector aeronáutico.

Problema: Las Lecciones Aprendidas, como herramienta para eliminar eventos no deseados, ha sido objeto de discusión por su alta recurrencia en los sucesos. Lo anterior es señal de que las Lecciones Aprendidas no son aplicadas eficientemente.

Objetivo: Este documento presenta una línea base destinada a reforzar el desempeño organizacional a través de la integración de los principios de Toyota Kata dentro de una metodología de Lecciones Aprendidas.

Metodología: Se realizó una integración kata-Lecciones Aprendidas utilizando puntos en común. Posteriormente, se implementó la integración empleando el Kata de mejora y el Kata de entrenamiento.

Resultados: Se detectó que las Lecciones Aprendidas tienen tres etapas similares al modelo Kata, etapas que son integradas. Adicionalmente, se evidencio la recurrencia de Lecciones Aprendidas en tres ítems. Por lo tanto, se desarrolla una guía de aplicación del modelo Kata-Lecciones Aprendidas alrededor de estas recurrencias.

Conclusión: La línea base, permitirá una aplicación apropiada del modelo Kata dentro del modelo de Lecciones Aprendidas. Permitiendo la inclusión a futuro de este modelo y aportando a la mejora continua de la industria.

Originalidad: Los resultados de esta investigación brindaran una guía práctica para el uso de un modelo de gestión moderno dentro del sector de mantenimiento.

Limitaciones: El modelo Kata-Lecciones Aprendidas debe ser probado en el área de operaciones para validar su eficiencia.

Palabras clave: Kata de entrenamiento; Kata de mejora; Lecciones Aprendidas; FAC; Toyota Kata, Mantenimiento.

Resumo

Introdução: Este artigo foi produto de um projeto de pesquisa da Força Aeroespacial Colombiana durante os anos de 2022 e 2023, sua constante busca pelo que há de mais moderno na gestão do conhecimento, desenvolve melhorias em seu modelo de gestão, contribuindo para a melhoria contínua da manutenção na Aeronáutica. setor.

Problema: Lições Aprendidas, como ferramenta para eliminar eventos indesejados, tem sido alvo de discussão devido à sua alta recorrência de eventos. O que foi dito acima é um sinal de que as Lições Aprendidas não são aplicadas de forma eficiente.

Objetivo: Este documento apresenta uma linha de base que visa fortalecer o desempenho organizacional através da integração dos princípios do Toyota Kata dentro de uma metodologia de Lições Aprendidas.

Metodologia: Uma integração kata-Lições Aprendidas foi realizada utilizando pontos comuns. Posteriormente, a integração foi implementada utilizando o Kata de melhoria e o Kata de treinamento.

Resultados: Detectou-se que as Lições Aprendidas possuem três etapas semelhantes ao modelo Kata, etapas que são integradas. Além disso, a recorrência de Lições Aprendidas ficou evidente em três itens. Portanto, um guia de aplicação do modelo Kata-Lessons Learned é desenvolvido em torno dessas recorrências.

Conclusão: A linha de base permitirá uma aplicação adequada do modelo Kata dentro do modelo de Lições Aprendidas. Permitindo a inclusão futura deste modelo e contribuindo para a melhoria contínua da indústria.

Originalidade: Os resultados desta investigação fornecerão orientações práticas para a utilização de um modelo de gestão moderno no setor de manutenção.

Limitações: O modelo Kata-Lessons Learned deve ser testado na área de operações para validar sua eficiência.

Palavras-chave: Treinamento de Kata; Kata de melhoria; Lições aprendidas; FAC; Toyota Kata, Manutenção.

1. INTRODUCTION

In today's manufacturing environment, organizations continuously seek methods to refine their operations, reduce waste, and enhance overall performance. The Toyota Kata management philosophy has emerged as a powerful approach to achieving these objectives, emphasizing continuous improvement, fostering a culture of experimentation and learning, and cultivating adaptive leadership [1]–[3].

Simultaneously, the Lessons Learned (LL) practice has become a crucial tool for addressing failures and preventing undesirable incidents [4], [5]. However, despite its recognized importance, LL is often underutilized or misapplied, leading to the recurrence of previously reported issues. This persistence highlights the need for an efficient and adaptable methodology—one that not only influences organizational culture but also ensures the effective implementation of LL across various processes.

Here’s a refined version of your text with improved clarity and flow:

This document presents **Phase One** of the project, which involves developing a model aimed at transforming organizational culture by merging the principles of Toyota Kata with the Lessons Learned (LL) methodology. To illustrate its application, a case study from the maintenance industry within the Colombian defense sector is used.

The document analyzes both the Kata model and the LL methodology, demonstrating how they can be integrated without compromising their original applications. This study identified key similarities between the LL process and a fundamental stage of the Kata model. As a result, the integration primarily occurs within these two stages, creating a balanced and cohesive framework.

The resulting integrated model consists of five progressive stages, requiring ongoing training and guidance from a coach or manager. It begins with the formulation of a long-term business vision (20–30 years). Next, a challenge is defined, spanning a maximum of three years. The third stage involves analyzing the organization’s current state using the Lessons Learned (LL) methodology.

In the fourth stage, a target condition is established, which is then achieved through the fifth stage—an approach based on scientific-experimental thinking. The outcome of this stage generates a new set of LL. At the end of the fifth stage, a new Target Condition (TC) is set, and the cycle repeats from the third stage onward, creating an iterative process of continuous improvement [6]–[12].

The final integrated model facilitates cultural transformation within an organization by implementing the Kata model. Additionally, it enhances individual and organizational performance through the consistent application and dissemination of LL. This document explores the integration methodology in depth, analyzes its potential implications and benefits, and provides recommendations and conclusions for implementing this model in the maintenance sector.

1.1 Literature Review

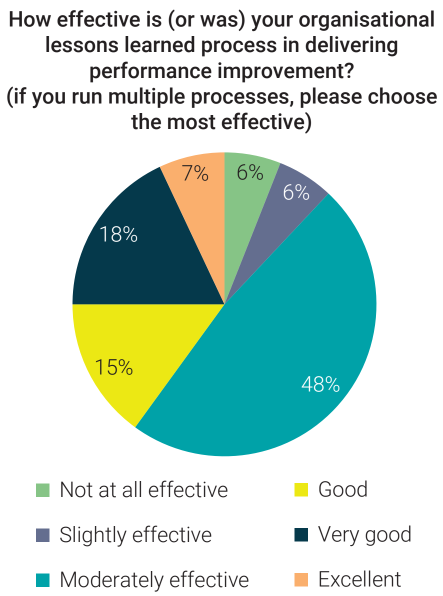
The pursuit of continuous improvement in organizational performance has led to the development of various methodologies and systems for learning from experience. One such approach is the implementation of Lessons Learned (LL), a framework designed to capture and apply knowledge gained from both successes and failures. However, the effectiveness of LL systems can vary significantly. Many organizations, despite having structured LL processes, struggle to achieve the expected outcomes.

A clear example of this challenge is presented by Nick Milton, who conducted a study evaluating the effectiveness of LL systems in various organizations. His findings revealed that, despite having theoretically well-designed systems, organizations face significant difficulties in ensuring their proper functionality [13]. To illustrate these challenges, Milton analyzed two case studies.

The first case involves an engineering company that had an LL system in place, albeit with limited application. Interviews with staff members revealed a significant lack of rigor in implementing LL. The identification and documentation of lessons were conducted inconsistently, informally, and in a fragmented manner. Furthermore, there was no defined process for utilizing Identified Lessons (IL); once lessons were recorded, they were often lost within the system, rendering it ineffective in driving performance improvements.

The second case focuses on a manufacturing organization where the LL system was centralized and operated under an incentive-based scheme. However, while this approach led to a high volume of submitted LLs, their overall quality was low. Additionally, despite the information being stored in a virtual portal, access was limited due to persistent technical issues, further reducing its effectiveness.

Milton's survey revealed a high level of dissatisfaction with LL systems, with the most common reasons being a lack of follow-up, poor management, organizational culture barriers, and time constraints, Figure 1.



Barrier or problem	No. of organisations
Lack of follow-through and application	15
Senior management	11
Culture	10
Time issues	4
Other	11

Figure 1. Effectiveness of LL processes: Left) Satisfaction with the LL process, Right) Reasons for dissatisfaction with the LL.
Source: [13]

In addition to this study, multiple investigations demonstrate that challenges and issues in the Lessons Learned (LL) collection process hinder the effective creation of knowledge within organizations [14]–[18]. The cases discussed earlier highlight the variable nature of LL, which can lead to either total success or failure in its application. Therefore, successful knowledge capture is essential and depends on a combination of time, resources, incentives, culture, and procedures. Balancing these factors and fostering a learning-oriented environment is crucial to maximizing the benefits of LL.

To overcome these barriers, management models supported by productivity- and flexibility-oriented philosophies have been introduced. Among the most widely recognized and implemented in the industry are Lean and Kata, both based on the Toyota Production System. The Lean philosophy incorporates various techniques aimed at improving operational processes within companies. There are approximately 101 Lean tools, with the most essential and widely used being Just-in-Time (JIT), Total Productive Maintenance (TPM), Autonomation, Value Stream Mapping (VSM), and Kaizen (Continuous Improvement, CI) [19], [20]. However, many companies struggle to successfully implement and sustain these methods because, while the techniques focus on process execution, they do not establish a structured routine for learning and practice.

To address this gap, the Kata philosophy was developed to cultivate learning habits, reinforce Lean methodologies, and facilitate a smoother transition for companies. In line with this approach, Brandl, Ridolfi, and Reinhart conducted a study examining the feasibility of adopting the Toyota Kata framework in business process design within a manufacturing company [6]. Their research, based on a case study in a complex manufacturing environment, included interviews with managers and employees involved in process design.

The study found that, while the Toyota Kata approach could be applied in complex manufacturing environments, certain adaptations were necessary. The authors emphasized the critical role of organizational culture and leadership in successful implementation. They also identified challenges such as the need for clear goals and objectives, as well as the importance of data analysis and experimentation in the process.

The book 7 Kata explores the integration of seven Kata methodologies to enhance the capabilities of the Toyota Kata approach within organizations [12]. The authors argue that combining these methodologies can significantly improve organizational performance by empowering employees to make decisions and drive continuous improvement. They stress the importance of leadership in developing a strong Kata culture and highlight the role of employee commitment and empowerment in sustaining improvements. The book also provides practical guidance for implementing the 7 Kata approach, including the development of a strategic plan, key performance metrics, and a training system to support continuous workforce development.

The work of Mike Rother is considered a foundational contribution to the Toyota Kata approach, which has gained significant recognition as a management philosophy focused on continuous improvement in organizational processes [1], [2]. Rother explains that the Kata model consists of two key components: the Improvement Kata and the Coaching Kata. He argues that, while Toyota has successfully applied this methodology, the approach is not exclusive to manufacturing organizations—it can be adapted to various industries and environments. However, he emphasizes that leadership commitment and a strong organizational culture are essential for successful implementation. Rother provides numerous examples of companies that have effectively applied the Toyota Kata framework.

Based on these readings, it can be concluded that the Kata model is both viable and flexible for integration with other existing organizational models, such as LL. Using the frameworks presented by Mike Rother and Toivonen as a foundation, the integration of LL and Kata can be explored effectively through the Plan-Do-Check-Act (PDCA) model when analyzing an organization's current condition.

2. METHODOLOGY

The case study for developing the Kata-LL model focuses on aeronautical maintenance within the defense sector. It will be analyzed through the lens of military culture, offering various benefits to doctrine by fostering habit formation, promoting best practices, and enhancing agile skills and methodologies for solving complex problems. Figure 2 illustrates an abductive analysis of the Kata methodology, divided into two key components: the Improvement Kata and the Coaching Kata. Both branches are interdependent and, therefore, must be applied together. These aspects are implemented through the development of five stages: 1) Vision, 2) Challenge, 3) Current Condition (CC), 4) Target Condition (TC), and 5) Plan-Do-Check-Act (PDCA). Additionally, both Katas are integrated with Lessons Learned (LL), emphasizing critical success factors and potential challenges in implementation, which can lead to a more significant impact on maintenance management. This section outlines the methods for fostering scientific thinking through the Kata model and its integration with LL.

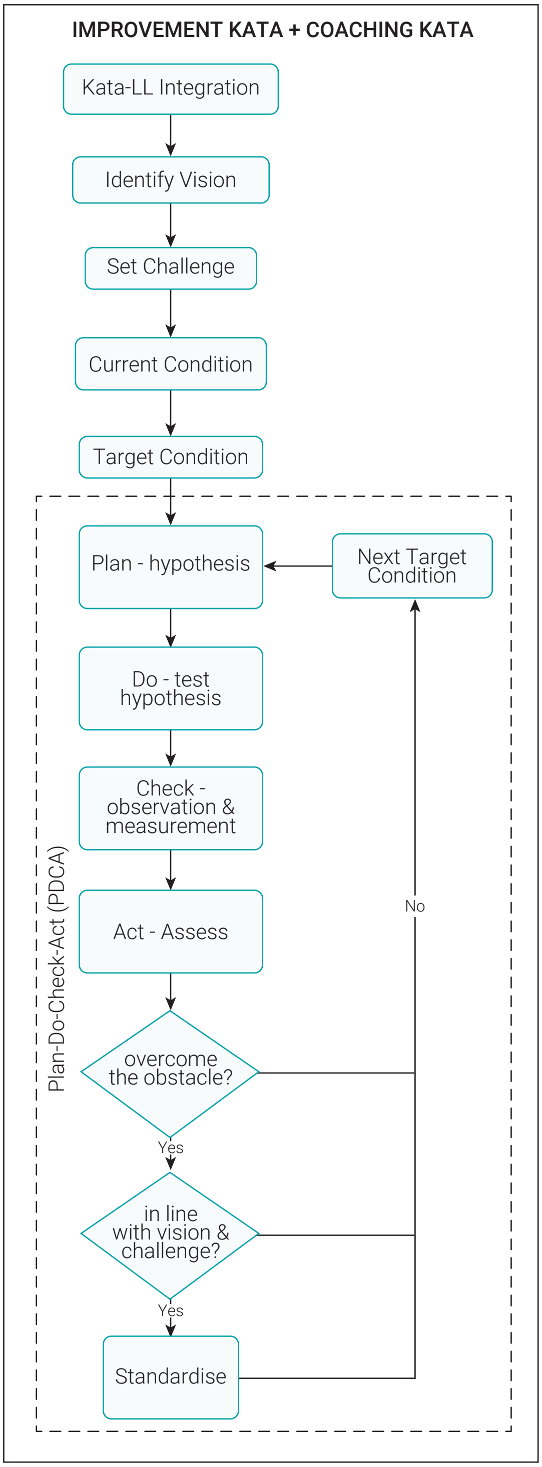


Figure 2. Toyota Kata methodology
Source: own work

2.1 Lessons Learned and Kata model integration

This section presents the integration of the proposed Kata model with the Lessons Learned (LL) model currently used by the Colombian defense sector [22]. To achieve this integration, a method based on identifying common points between the two models will be employed. This method involves analyzing the structures and stages of both models to pinpoint common elements that can serve as integration links. Once these points are identified, the two models will be integrated, resulting in a unified work structure. The integration facilitates a smooth and low-impact transition, leading to a reduction in events in aeronautical maintenance through improved routines and cultural modifications.

2.2 Identify the vision, direction or objective

The vision should be formulated for the long term (between 20 and 50 years). It remains unchanged and serves as the central guiding axis that drives the achievement of all organizational objectives. In the case of aeronautical maintenance in the defense sector, this vision is defined and governed by institutional policies.

2.3 Set the challenge

The challenge serves as a medium-term goal that allows the organization to work toward its long-term vision. It is typically defined over a period of 6 months to three years. This stage helps align and connect the organization's workforce to achieve a common objective, fostering improved teamwork and communication. The challenge is usually defined by team leaders based on their experience, a broader understanding of the team, and the current state of the company. A practical way to set the challenge is by completing the sentence: "Wouldn't it be great if we could...?" [2]. It is important that the challenge be measurable, engaging, have a clear timeline, and be developed by all relevant teams.

2.4 Identify the Aeronautical Maintenance Unit Current Condition

In the Toyota Kata methodology, understanding the current state of the organization is a key step. This phase sets the foundation for achieving the Target Conditions (TCs), based on observations, interviews, and historical data. According to Mike Rother, this methodology is divided into two parts [1], [2]:

1. Data Collection: Gathering historical and available data from open sources.
2. Genchi Genbutsu: Collecting data through direct observation and interviews.

2.4.1 Historical data analysis

For historical data analysis, it is essential to define the focus within the organization. Once the focus is identified, all relevant historical data should be collected to assess the organization's performance to date. The maintenance units and Lessons Learned will serve as the historical database for the defense sector. The collected data will be analyzed to validate the priority of the Target Conditions and establish a baseline for continuous comparison and measurement of changes and improvements.

2.4.2 Maintenance process analysis

The analysis of the maintenance process, based on the Genchi Genbutsu principle, will determine the foundation for applying strategies and prioritizing their implementation to achieve optimal results in maintenance management. This analysis will consider the organization's doctrine, maintenance unit structure, and operational processes.

2.5 Set the Target Condition

Starting from the vision, the challenge, and the current state of the value process, the TCs for each process in the organization are defined. These TCs must have specific deadlines, establishing clear roadmaps and goals for the short, medium, and long term. The short-term monitoring methodology is typically defined over a period of one week to three months. Each TC includes the following components:

1. **When?** (Compliance date)
2. **What?** (Desired result)
3. **How?** (Specific work plan to achieve the TC)

If an organization is unclear about the value flow of its business or processes, defining relevant and productive TCs becomes unfeasible. Therefore, management must establish these elements to align challenges, strategies, and expected results. Once the configuration for TCs is in place, work plans are developed for each TC, and their progress is monitored weekly to identify and correct any errors or obstacles.

2.6 Plan-Do-Study-Act

Continuous improvement is based on Deming's quality circle, which forms the foundation for building management routines based on the Kata thinking model [23]. The development of action plans and evaluation of effectiveness helps determine whether a TC has been achieved or if a strategy change is required. The systematic routine, using the experimental method with flexibility in the short term, explores all possible routes to achieve the TC via the scientific method. The following questions guide this process:

- **What is the current knowledge threshold?**
- **What needs to be learned to surpass this threshold?**

Based on these questions, a series of experiments are developed to explore spatial data. Through this iterative process, the broader knowledge threshold is acquired. The next step applies a scientific learning cycle (PDSA), which follows the cycle of prediction, testing, observation/measurement (data collection), and evaluation. An example is presented, based on the TCs established in the previous section. This scientific cycle is repeated until the TC is achieved. Once the TC is reached, the successful results or Lessons Learned are standardized through regulations or manuals, and the PDSA cycle begins again with a new TC. It is important to document the entire cycle in tables for better visualization of the process and its progress.

2.7 Coaching Kata

The Improvement Kata cannot succeed unless the organizational culture is modified and aligned with the five stages mentioned earlier. Achieving this mindset within an organization requires the Coaching Kata model. This model proposes a transformation of the company's current culture through systematic practice and training. To achieve this, a Coach with experience in applying the Kata training model is essential.

Once the Coach is in place, the five key Kata questions should be applied [2]:

1. **What is the Target Condition?**
2. **What is the Current Condition?**

- Reflection of the previous cycle:
    - What was the last planned step?
    - What result was expected?
    - What actually happened?

- What was learned?
- What obstacles arose?

3. **What is the next step or experiment?**
4. **When will this step be fully developed?**

These five Kata training questions should be answered daily, with each session lasting no more than 20 minutes. The cycle of questions and answers should be documented in tables to allow daily progress to be clearly visualized.

As in the previous sections, Phase 1 of this project includes an example of how to execute this model, and tables will be proposed to help track progress. This will serve as a foundation for implementing the model practically in a maintenance unit during Phase 2 of the project.

3. APPLIED LESSONS LEARNED AND KATA

3.1 Current Lessons Learned Structure

Figure 3 illustrates the LL work structure within the maintenance organization. The LL process is divided into four stages and is implemented each time a new work plan is developed to address a challenge in fulfilling a Target Condition (TC) [24].

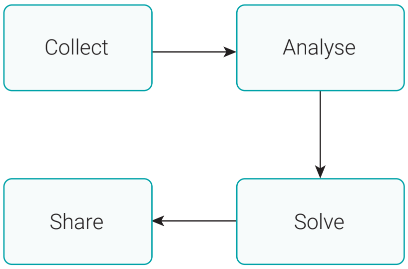


Figure 3. Aeronautical maintenance LL structure within the Colombian defense sector
Source: [22]

3.1.1 Kata model structure

The structure of the Kata model is illustrated in Figure 2. It consists of five main stages: 1) Vision, 2) Challenge, 3) Current Condition (CC), 4) Target Condition (TC), and 5) Plan-Do-Check-Act (PDCA). The integration of the current Lessons Learned management system with the proposed Kata methodology is solidified through the implementation feasibility analysis.

3.1.2 Integration points

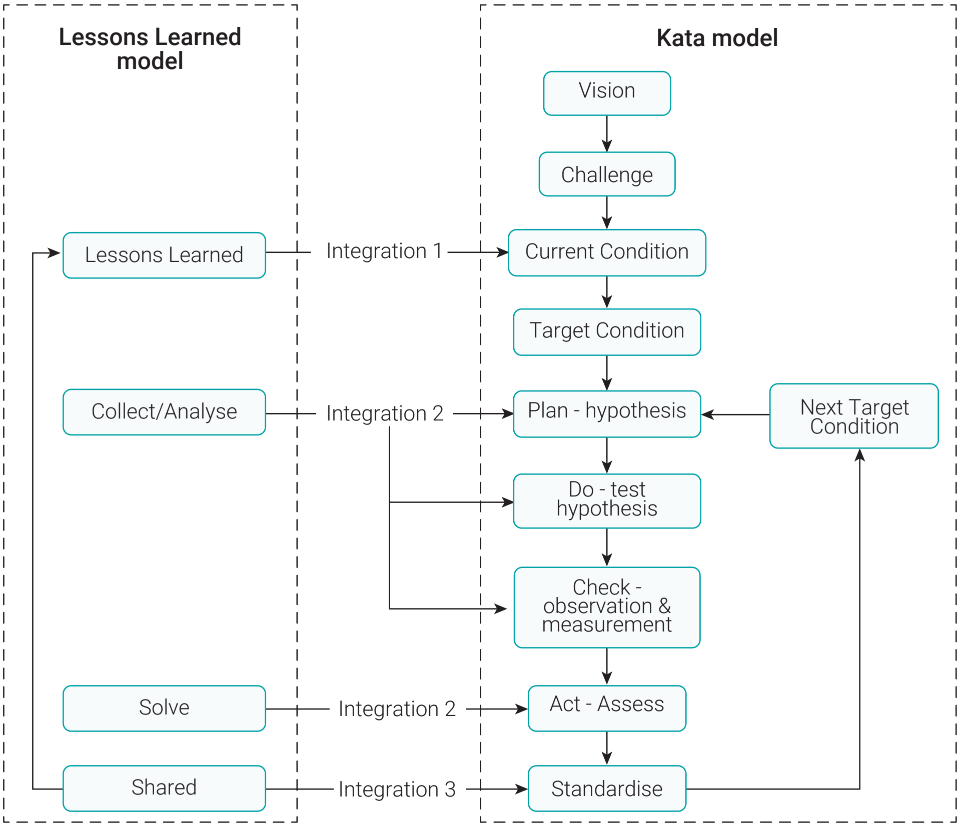


Figure 4. Kata model integration with LL
Source: own work

Once the Lessons Learned (LL) and Kata models have been analyzed, it becomes evident that both models share three key integration points that enable a final integration, as shown in Figure 4.

Integration 1 (Input Data): This occurs in the Current Condition (CC) stage (Kata). At this point, the LL collected within the organization (as historical data) is used to identify recurring events that contribute to the identification of the CC.

Integration 2 (Merging of Stages): This takes place in the Plan-Do-Check-Act (PDCA) cycle (Kata). The plan-hypothesis, do-test hypothesis, and check-observation

& measurement (Kata) merge with the collect/analyze (LL) stages. Additionally, the act-assess (Kata) merges with the solve stage (LL).

Integration 3 (Output Data): This is presented during the standardize stage (Kata), where the results from the PDCA cycle are used to standardize (Kata) or disseminate and share (LL), translating these results into LL used to restart the PDCA cycle.

It is important to note that the scope of the model pertains to its application in current management. The proposal for a new model will be addressed in a subsequent article, where the evolution of the topic will be explored.

3.2 Vision and direction

The following vision was established as an initial parameter: "Exercise dominance in air, space, and cyberspace" as the basis for aeronautical maintenance [25]. Consequently, the entire organizational structure, both central and decentralized, must work towards fulfilling this vision..

3.3 Challenge

Taking into account the vision and the study sector, the challenge must meet the organization's established parameters and fulfill its vision through aeronautical maintenance support. Therefore, maintenance units must ensure the availability of aircraft to exercise air, space, and cyberspace power. For the current study, this availability focuses on fixed-wing, rotary-wing, and unmanned aircraft within the organization. The following question is asked, based on the recurrence of unwanted events recorded as LL:

"Wouldn't it be great if we could reduce the occurrence of Operational Safety (OS) events due to maintenance factors?"

As a result, the challenge is established as: Zero OS Events due to maintenance factors. This challenge is set for a maximum period of three years and will be broken down into achievable short-term objectives.

3.4 Current Condition

Within the cycles of the current Kata-LL model, the need to collect data involving LL is evident. The first challenge is to unify the categories and subcategories derived from the statistical analysis of the LL. The second challenge is to validate these categories and determine which are relevant for conducting in-situ analysis with aeronautical maintenance personnel. The third challenge is to establish a short-term monitoring tool for the established categories with defined analysis criteria. This process requires identifying the current state and projecting the study area.

The CC of the organization was analyzed from the military doctrinal perspective and through the LL. While the results are somewhat restricted in use, they have identified priorities and variables, leading to the validation approach of activities by expert personnel assigned by the senior management of the organization. These analyses allow the generation of TC and provide a clearer visualization of the organization's structure and operation.

3.4.1 Lessons Learned Analysis

A total of 97 LL records from various maintenance units were collected by the organization, covering events from the past 13 years. These records detail the year of the event, the affected fleet, the unit where it occurred, and the associated LL. The analysis was conducted to identify recurring issues in maintenance operations, leading to the creation of a matrix that highlights these recurrences and helps establish the TC.

3.4.2 Lessons Learned Matrix

The creation of the LL matrix was based on doctrinally accepted parameters adopted by the Colombian Ministry of National Defense, which uses the following capacity components: Doctrine, Organization, Material and Equipment, Personnel, and Infrastructure (DOMPI) [26]. By aligning each parameter with the concept of capabilities, the recurrences in LL were further specified. The components and their subcomponents were determined based on the structure established in the Aeronautical Maintenance Manual (MAMAE), the Methodological Planning Guide by Capacities, the Methodological Guide for the Development of the Military Forces TOE, and with the support of FAC personnel [26]–[28]. This structure ensures that the doctrine aligns with the LL recurrence analysis categories.

Table 1. matrix components and sub-components

Component	Sub-component
Doctrine	Implement/update format
	Implement/update instructive
	Implement/update procedure
	Implement/update directives
	Implement/update manuals
Organisation	Management decisions
	Organisational processes
	SAP system reliability
	Structure
	Control/supervision
Material & equipment	Failure/damage
	Maintenance work
	Tracking/monitoring
	Availability/stock
Personnel	Education
	Training
	Capacitation
	Personnel availability
	Morale (benefits, salaries, among others)
Infrastructure	Installations
	Training areas

Source: own work

3.4.3 Matrix Results

The analysis highlights 7 recurring events that appear in 19 LL records. As shown in Table 2, these recurring events mostly occurred in different years, suggesting that the LL were either not applied appropriately, were insufficient to resolve the problem, or the knowledge was lost over time. Furthermore, two events reported in January 2023 were still under investigation in October 2023, without an established LL. This case demonstrates that LL are not being generated quickly, effectively, or in alignment with the continuous change needs of the organization to respond to maintenance operations.

Table 2. recurring events

Component	Sub-component	Recurrences	Years
Doctrine	Implement / update format	2	2010 & 2013
Personnel	Capacitation (weight)	2	2010 & 2013
Personnel	Capacitation (180 turn during taxi)	2	2010 & 2013
Doctrine	Implement / update format, instructive and procedure	2	2019
Personnel Infrastructure	Training Installations	3	2021 & 2022
Material & Equipment	Maintenance work	4	2021 & 2022
Personnel	Training	4	2021 & 2022

Source: own work

The analysis of the 97 LL data collected for the matrix, which is presented in the Final Research Report of the EPFAC [29-30], identifies key patterns and recurring issues in the maintenance operations over the past 13 years. Figure 5 shows that the components of Doctrine, Material and Equipment, and Personnel are the ones with the most recurring events. Therefore, these three components will be detailed further.

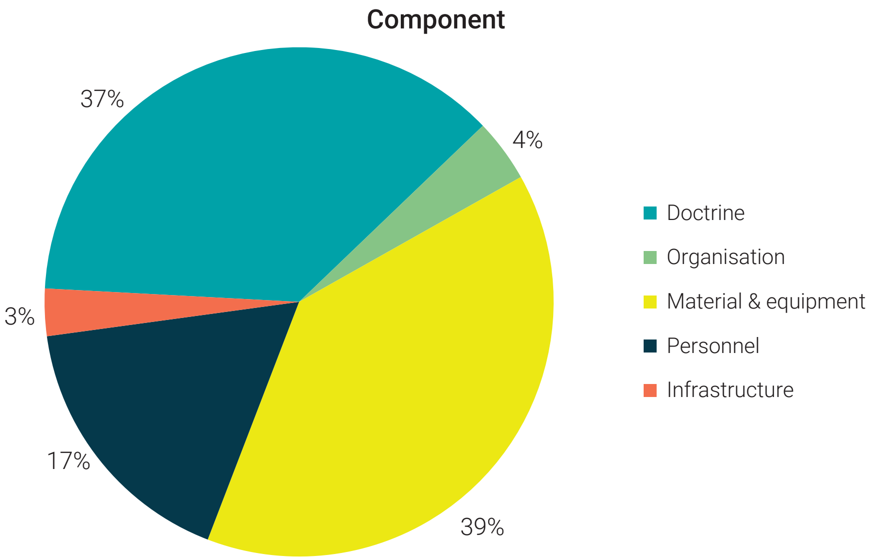


Figure 5. distribution of LL by components
Source: own work

Within the Doctrine component, the implementation/update of format and procedure sub-components generate the most recurring events and LL, as shown in Figure 6. This highlights a recurring need for modifications to procedures and the generation of reports to communicate problems that arise during maintenance operations.

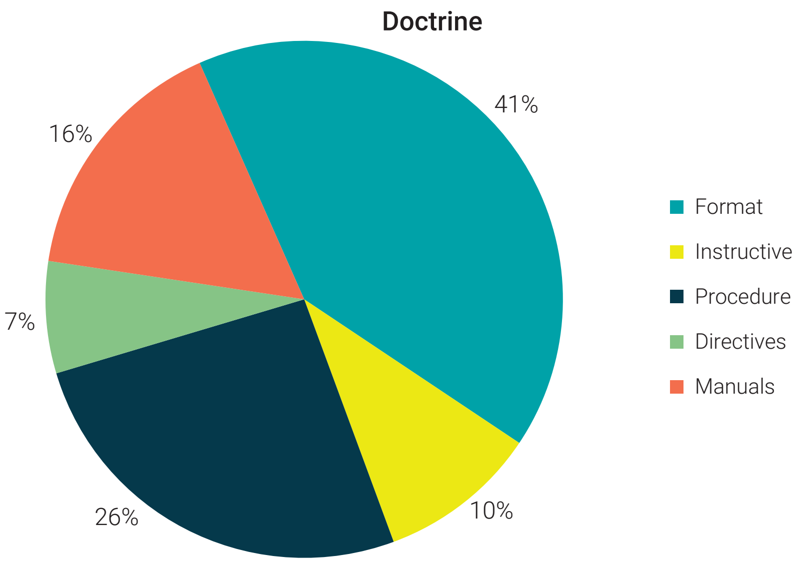


Figure 6. distribution of LL by doctrine sub-component
Source: own work

As for the Material and Equipment component, Figure 7 shows a nearly homogeneous recurrence across all sub-components. Notably, maintenance work (which includes all types of maintenance such as inspections, assemblies, and modernizations) accounts for 36% of recurrences, followed by tracking/monitoring at 23%. The availability/stock and failure/damage sub-components each account for 20%. This recurrence indicates a direct relationship between the LL and the functionality of the maintenance units, where the handling of equipment and materials is a critical aspect of the maintenance process. The data suggests issues with poor planning related to material availability and inadequate monitoring of repaired or altered equipment after installation.

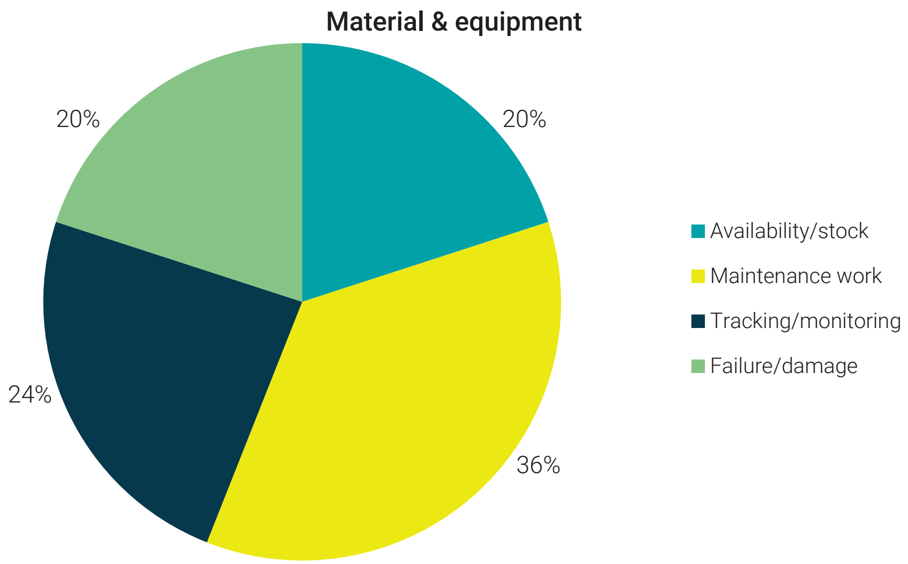


Figure 7. distribution of LL by material and equipment sub-component
Source: own work

Regarding the Personnel component, Figure 8 highlights a constant need for training or re-training of maintenance personnel due to frequent errors during maintenance tasks. This reflects a possible skill gap or lack of up-to-date training within the workforce.

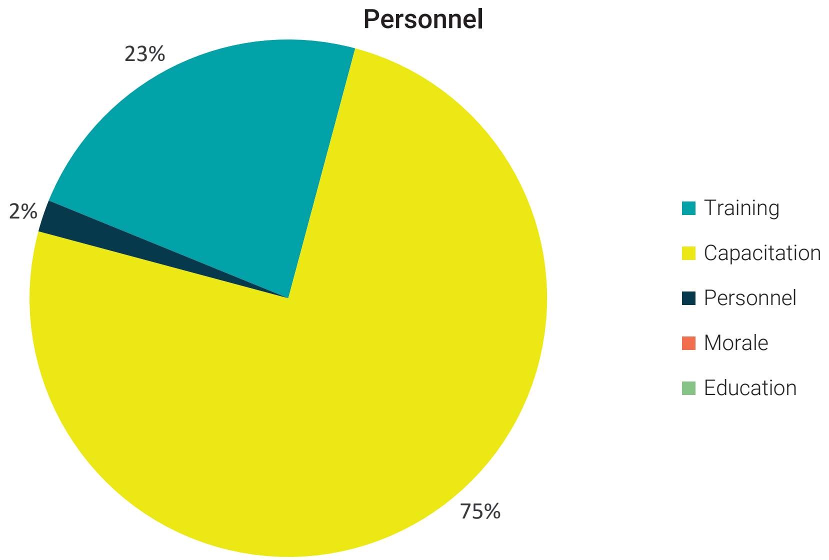


Figure 8. distribution of LL by personnel sub-component
Source: own work

3.4.4 Operational process

Figure 9, illustrates a value stream map of an engine maintenance process. This diagram provides a detailed flow of how maintenance activities are organized within the system. The process begins with receiving the customer's aircraft and progresses through various stages of engine disassembly, inspection, testing, and reassembly. Notably, the accumulation of engines between stages 2 and 3 points out a potential inefficiency in the process, highlighting a bottleneck. A possible solution could be to create a second maintenance line or increase the number of operators at the disassembly stage to improve the flow.

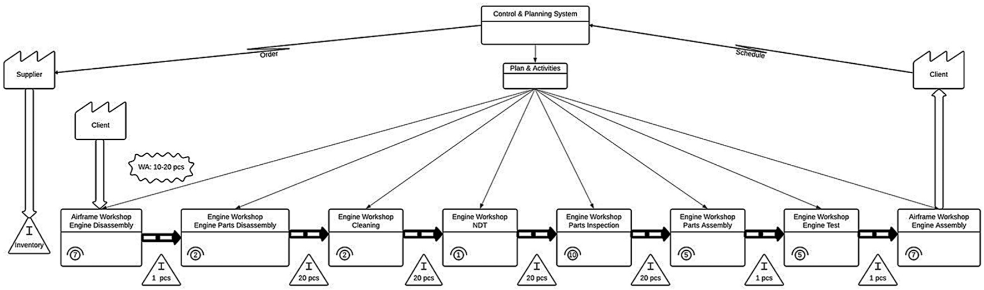


Figure 9. value stream map of the engine maintenance workshop process
Source: own work

3.5 Current Condition Analysis

An example of the Current Condition (CC) is presented in Table 3.

The historical data row includes partial results from the LL analysis, showing patterns in maintenance activities. The performance indicators row presents an example with three factors:

- Requirement (e.g., 10 maintenance jobs per day),
- Current indicator (e.g., each maintenance job takes 5 man-hours),
- Planned indicator (e.g., 3 man-hours for each maintenance job).

The operation row includes details about the stages in Figure 9, the time required for each stage, and any observations about the process. Lastly, the equipment capacity row highlights any shortcomings related to the equipment used throughout the maintenance process.

This analysis points to inefficiencies and potential areas for improvement in the maintenance operations, helping set the stage for defining Target Conditions (TCs) and continuous improvement actions.

Table 3. Current Condition summary

Date: DD/MM/YYYY		Current Condition
Historical Data*	Current result 1	Doctrine 37% recurrences
	Current result 2	Material & equipment 39% recurrences
	Current result 3	Personnel 17% recurrences
Performance Indicators*	Requirement	F2
	Current Indicator	F2
	Planned Indicator	F2
Operation*	Process stages	Figure 9
	Time Variations	F2
	Observations	An accumulation of engines is generated between engine disassembly and parts.
Equipment Capacity*	Limitations or restrictions on equipment	F2

* Partial or example results.
F2: Results to be obtained during an operational area visit

Source: own work

3.6 Target Condition

Once the Current Condition (CC) study is completed, the next step is to define the Target Conditions (TCs), which are aligned with the vision and challenge. Based on the results obtained from the Lessons Learned (LL) analysis, specific TCs have been proposed for each component. Below are the detailed TCs for each component:

Doctrine (format/procedure): One of the problems identified in the Doctrine component is the high number of documents. This issue can be addressed by reviewing and standardizing the existing documentation. The proposed Target Condition (TC) for this component is to "Maintain documentation relevant to production processes with modifications aimed at productivity and added value to the process based on capabilities." This will be achieved through the review of existing documents and the creation of macro formats (standardization) that can be applied to various types of processes. The goal is to reduce the number of documents while still maintaining comprehensive and effective documentation. A development time of 6 months is proposed to complete the review and standardization of documentation.

Materials and equipment (monitoring/failure/availability/maintenance): In this component, it is evident that there is a deficiency in the planning process and monitoring. Therefore, the following TCs are proposed: “Maintain the flexibility of adjustments to the execution of the total planned aeronautical maintenance programs, with a maximum deviation of 10%.” The key factors to establish the short-term challenges are as follows: “Management with on-time contracting processes and available materials” and “Constant monitoring of installed components.” In the first TC, technological tools will be implemented to allow more efficient and real-time inventory management, with an execution time of 3 months. The second TC requires training to make staff aware of the importance of constant monitoring, with an execution time of 1 month.

Finally, the personnel component shows a high recurrence of requests for training. This may be occurring due to various factors, such as the hiring of personnel who are not suitable for the position, poor training planning, or low-quality training, among others. The author considers it important to start with a TC aimed at improving annual training. Therefore, the following TC is proposed: “Implement an annual training plan with topics related to Lessons Learned.” Historical data will be collected through LL to identify the topics that require staff training, with an execution time of 1 month.

Compliance with the above Objective Conditions will enable us to meet the proposed challenge of reducing the occurrence of operational safety events due to maintenance factors.

3.7 Plan-Do-Check-Act (PDCA)

To consolidate the model, the following structure is proposed for implementing the TCs. The PDCA method is applied within the TCs. This section presents an example to illustrate the PDCA procedure from the Kata perspective..

3.7.1 Plan

The first step is to propose the hypothesis or predict what actions will be needed to achieve the TC. Within the LL, a recurring error occurs in the application of paint on aircraft. Starting from this fact, and to achieve the goal of developing an annual training plan, it will be necessary to verify and measure step by step the procedure followed by the painting staff. Table 4, shows a general procedure for applying paint to an aircraft. Based on this, a plan is generated to allow for monitoring, understanding, measuring the process, and obtaining results for further comparison.

Table 4. proposal to develop a training plan in paint application

Procedure stage		Plan - Fulfils?
Surface preparation	Inspection	YES/NO
	Cleaning	
	Paint removal	
Surface treatment	Engraving	
	Conversion coating	
Primer	Application	
	Cured	
Surface protection	Tape covering	
Top layer	Application	
	Drying	
Quality control	Inspection	
	Correction	
Result		No. Failures

Source: own work

3.7.2 Do

In this stage the plan is executed within the operational area (Genchi Genbutsu). Table 5 contains an example of the execution of the proposed plan. As a result, it was found that personnel were failing in three key areas: surface engraving, covering sensitive surfaces with tape, and correcting errors in the paint application. These three failures are considered obstacles in the Kata model. The goal is to eliminate these obstacles, for example, through targeted training

Table 5. implementation of the proposed plan

Procedure stage		Plan (Fulfils?)
Surface preparation	Inspection	YES
	Cleaning	YES
	Paint removal	YES
Surface treatment	Engraving	NO
	Conversion coating	YES
Primer	Application	YES
	Cured	YES
Surface protection	Tape covering	NO

(continúa)

(viene)

Procedure stage		Plan (Fulfils?)
Top layer	Application	YES
	Drying	YES
Quality control	Inspection	YES
	Correction	NO
Result		3 Failures

Source: own work

3.7.1 Study

During this step, a verification of compliance with the procedure is conducted after the training is completed. It is normal that at this point, other obstacles may arise that prevent the initial failures from being fully resolved. Table 6 shows that the correction (quality control) still presents a non-compliance event. Therefore, training focused on correction is required, and the PDCA cycle begins again with a new TC to address this recurring event. The cycle is repeated until all obstacles are eliminated and the proposed challenge is achieved.

Table 6. post-training procedure verification

Procedure stage		Plan Fulfils?	Current Fulfils?
Surface preparation	Inspection	YES	YES
	Cleaning	YES	YES
	Paint removal	YES	YES
Surface treatment	Engraving	NO	YES
	Conversion coating	YES	YES
Primer	Application	YES	YES
	Cured	YES	YES
Surface protection	Tape covering	NO	YES
Top layer	Application	YES	YES
	Drying	YES	YES
Quality control	Inspection	YES	YES
	Correction	NO	NO
Result		3 Failures	1 Failures

Source: own work

3.7.2 Act

At this point, all the information about the process is collected, and LLs are analyzed. For instance, in the case of aircraft painting, new application techniques were introduced during the training, such as teamwork skills, thinking outside the box, and analytical skills. These improvements were likely acquired, and it is certain that people learned to consistently perform the necessary paint corrections. These learnings can be recorded as positive or negative LLs. Ultimately, LLs will be transformed into standards and procedures.

3.8 Coaching Kata

Coaching Kata is the method that continuously practices the Improvement Kata. Therefore, applying this model is crucial for modifying the organizational culture. The routine proposed by Mike Rother requires its daily application for a maximum of 20 minutes [2]. Table 7 presents a guide format that compiles the results of the Improvement Kata. This format clearly and fluidly develops the five Coaching Kata questions presented in Section 2.7. The format should be worked from top to bottom, starting with the area of focus, followed by the challenge, the TC with a stipulated completion date, the QC, the record of results from the experiment cycle or PDCA, and concluding with the obstacles encountered. Table 7 presents as an example the results obtained in this project.

Table 7. guide poster

Focus area: Support Workshop	
Challenge: Zero OS Events due to maintenance factor	
Compliance date: DD/MM/YYYY **Target Condition:** Annual training plan implemented with topics related to LL	All the results obtained in section 3.7 are located in this space.
Current Condition:	All the results obtained in section 3.6 are located in this space, included Table 3.
Experiment log:	All the results obtained in section 3.8 are located in this space, included Table 4, Table 5, Table 6.
Obstacles:	• Surface engraving.
	• Covering surfaces with tape.
	• Error correction

Source: own work

4. CONCLUSIONS AND FUTURE WORK

According to the literature review, it is evident that maintenance companies require a Lessons Learned (LL) model as a component of continuous improvement. However, different studies have shown that poor practices and organizational culture reduce the effectiveness of LL. The implementation of the Toyota Kata model helps to address the shortcomings of LL by improving habits and modifying the company culture. This study demonstrates that the added value of integrating Kata with LL is to make complex events (such as LL) visible and segmented, allowing them to be resolved in a practical and scientifically grounded way through habits and organizational culture modifications.

To achieve this, it was necessary to integrate the two models at three common points that allow for fluid and organized work. A case study of the Kata-LL model is presented as a foundational guide for companies. This guide introduces and develops five steps: establishing a vision, defining a challenge, assessing the Current Condition, setting a Target Condition, and conducting an experimental cycle (PDCA).

The case study was conducted using data from aeronautical maintenance in the defense sector as the example maintenance company. The sector's 20-year vision to exercise dominance in air, space, and cyberspace was used as a basis. Consequently, the availability of aircraft was identified as a major issue preventing the fulfillment of this vision. Thus, a challenge was defined to reduce the occurrence of operational safety events due to maintenance factors. The analysis of the organization's Current Condition was carried out through LL, revealing that 37% of event recurrences were due to doctrinal factors, 39% to material and equipment factors, and 17% to personnel factors. From this analysis, the need emerged to reduce the number of formats used by the organization (TC 1), improve inventory management, contracting, and monitoring processes (TC 2), and create a training plan to reduce LL recurrence (TC 3).

Additionally, the value stream map highlighted the accumulation of engines in one of the stages of the engine workshop process, leading to increased maintenance times. However, this analysis and the development of TC will be finalized once more data is collected during a visit to the operational area.

One of the three TCs was selected due to events caused by poor paint application practices and the need for staff training. The experimental cycle revealed three obstacles: surface engraving, covering sensitive surfaces with tape, and correcting painting application errors. Of these, the first two were effectively addressed through training. However, it was found that to resolve the third obstacle, the training needed to include a procedural checklist. Finally, the Kata-LL model is reinforced through daily training, which fosters habit formation and modification of the organizational culture.

This project developed and implemented the Kata-LL model in the defense sector. The baseline guide presented in this document will enable other organizations to apply the Kata-LL model, helping them establish practical habits and modify their culture in an effective way.

As future work, a second phase will be conducted in the operational area, allowing for the collection of data to strengthen the analysis and results of the current work.

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